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KYANCUTTA MUSEUM

Kyancutta, South Australia.

Further Notes on

Archaeos (Pleospongia)

From the LOWER CAMBRIAN of South Australia

By

R. & J. BEDFORD

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Since our third memoir was published last year, we presented at the Auckland meeting of the Australian and New Zealand Association for the Advancement of Science a paper on the Structure and Classification of Archaeos. Mimeographed copies of this paper have been distributed, and, at a later date, we hope to revise the matter and print it as a memoir. We are also getting together a collection of photographs of material specially prepared for this purpose, with a view to publishing a series of photographic illustrations.

We have received from Dr. V. J. Okulitch notes of a paper presented by him at the Cincinatti meeting of the Geological Society of America, in which certain changes in nomenclature are proposed.

Owing to preoccupation of the name Cyathospongia proposed by Dr. Okulitch for the class, he now suggests *Pleospongia*, which name we have accordingly adopted.

Both Dr. Okulitch and ourselves had discovered the preoccupation of our name Heterocyathus, for which Dr. Okulitch proposed to substitute Radiocyathus and we Hetairaccyathus; in a letter Dr. Okulith has very courteously offered to withdrawn his proposal, and we propose to continue to use the names *Hetairacyathus*, *Hetairacyathidae* for our genus and family, and *Hetairacyathina* for Dr. Okulitch's order.

Dr. Okulitch also proposed to use the name Archaeocyathidae instead of Spirocyathidae, and to use Cambrocyathidae for "Archaeocyathi with straight parietes as represented by *A. profundus* Billings." As we have not yet seen the full text of Dr. Okulitch's paper, and the correlation of the Australian and American forms presents considerable difficulty, we are, in this paper, continuing temporarily to use the names Spirocyathidae and Archaeocyathidae in the same sense as in our previous memoirs.

Order *SPIROCYATHINA.*

New Species *Protopharetra furca.*

This fossil occurs in rather poor preservation in association with *Beltanacyathus ionicus* near the "Paint Mine," Beltana. Most of the specimens are surrounded by exothecal tissue which forms a common investment to them and the associated Beltanacyathus. We conclude that this exothecal tissue is probably a parasitic investing form related to that which is described later in the present paper under the name of *Exocyathus* and to Vologdin's *Labyrinthomorpha* (Archaeocyathinae of Siberia, 1931, p. 35, and Plates V, VIII, X, XIV, XVI). The most striking feature of *Protopharetra furca* is its branched form, as is well seen in Plate XXVII, Fig. 106 Aa, in which the left-hand specimen, seen approximately in transverse section, has a four-lobed outline and four distinct central cavities. In this figure, b is a section of *Beltanacyathus*, and c is a common investment of (?) *Exocyathus*. Fig. 106 B shows a part of the same specimen enlarged, with two of the lobes and their cavities cut transversely, and a third lobe (bottom right) obliquely; *Exocyathus* tissue is seen cut transversely, partly surrounding the left-hand lobe. The outer wall, though defined, does not give a clear view of the pores because of the attached *Exocyathus*. The intervallar mesh is of fairly regular open texture, composed of round rods spaced, on an average, about half a millimetre apart. There is little or no sign of such a radial arrangement of the rods as is seen in *Spirocyathus*. The inner wall is clearly defined, but so far we are not quite satisfied as to the nature of the pores. In the type specimen some pores appear to be about $\frac{1}{4}$ mm. diameter, whilst in a few places smaller, more numerous pores appear to be present; in another specimen, which may be the same species, the inner wall seems to have more uniform pores, $\frac{1}{4}$ mm.

diam., averaging two pores to the mm., see Fig. 106 C. The intervallum coefficient averages 2 mm.: 2 mm., the central cavity being narrow. In its branching form and the general character and scale of its tissues *Protopharetra furca* has a very strong resemblance to Bornemann's Sardinian species *Protopharetra polymorpha* (Versteinerungen . . . Sardinien, 1886, Plate V).

Bornemann, in the work just quoted, gives on Plate XXXII very fine photographs, in transverse and longitudinal sections, of a Canadian form which he states to be *Archaeocyathus profundus* (Billings). These photographs show what we, on the lines of our present paper, should describe as an Archaeo cup surrounded by several more or less concentric laminae of an "*Exocyathus*"-like parasitic growth. The central cup itself, in the transverse section, looks "*Protopharetra*"-like, but in the longitudinal section, waved septa are seen, together apparently with dissepiments, thus resembling our "*Metacyathus.*" Figures of *profundus* were also published by Walcott and by Hinde; most of these figures show resemblances to what we have called "Metacyathus"; but Walcott's Plate II, Fig 3, 3a (1886) is more "*Archaeocyathus*"-like. At a risk perhaps of "making confusion worse confounded," we suggest for the consideration of American and Canadian workers enquiry whether more than one form has been included in descriptions of *A. profundus*, what is the relationship to the Australian "*Metacyathus,*" and whether a parasitic growth is present on some of the specimens.

Our fossil is thus particularly interesting for the contact it makes in itself with the Sardinian *Protopharetra polymorpha* and in its surrounding zone with the Siberian *Labrinthomorpha* and the Canadian *A. profundus*.

New Species *Protopharetra radix.*

This is a scarce little cylindrical form which it is difficult to correlate with other species. The holotype is 3 mm. diameter, cylindrical. The outer wall is thick and clearly defined, but pores cannot be made out, possibly because of being obscured by secondary silicification. The interior is occupied by an anastomosing mass of bars. The bars are not circular in section, but flattened, with rounded corners; their direction is sloping, but they approach a longitudinal rather than a transverse orientation. There is no inner wall or central cavity. Pending revision of the whole group we label it *Protopharetra*, though it is evident that the one generic name cannot cover such distinct types as this and *P. furca.* Our specimen is shown in trans. sec. in Plate XXVII, Fig. 107 A, and in longit. sect., Fig. 107 B.

New Genus *Flindersicyathus.*

Dr. Okulitch has recently pointed out (Cincinatti meeting of Geol. Soc. Amer. 1936) that the generic name *Spirocyathus* was wrongly used in the first instance and must be abandoned. There occur at the Ajax Mine several species hitherto known as "*Spirocyathus*" which are characterised by an intervallar tissue of curved hexagonal-tubular lattices (see our Memoir No. 2, p. 15) and by an inner wall with large pores leading upwards and inwards into the central cavity. For species presenting this combination of characters we propose the new generic name *Flindersicyathus*, to include the species *irregularis*, (?) *multifidus*, *ptychophragma*, and *rete*, together with four new species herein described. *Pycnoidocyathus* is regarded as a development of this type.

New Species *Flindersicyathus decipiens.*

There occur at the Ajax Mine two species of "*Spirocyathus*" which are very similar in general appearance, in the intervallar mesh and in their inner walls. One of these is described by Taylor as *Spirocyathus irregularis*, and is shown in photographs 93 and 94, Plate XVI of his 1910 Memoir. In this form the intervallar mesh, as seen in radial longitudinal section (see lower left part of Taylor's photograph 94), shows a horizontal orientation of the rod-lattices near the outer wall, changing to a downward dip near the inner wall; in a tangential section just below the outer wall (see left-hand of Taylor's photograph 93) the maze-like arrangement of the rods is characteristic. We figure the outer wall of this species in Plate XXVII, Fig. 108 A, and a transverse section in 108 B. There is no defined porous plate forming the outer wall, the pores being merely the interstices between the elements of the superficial maze of rods, and this maze further throws outwards numerous short tubercles (see upper part of our Fig. 108 A, and upper part of 108 B). In consequence sections of *F. irregularis* often look as if the outer wall is missing (see left-hand side of Taylor's photograph 94). Our new species, *Flindersicyathus decipiens*, has a more defined porous outer wall, without protruding tubercles; this is shown in Fig. 109 A, B. The pores are small and numerous, about 4 : 1 mm. Besides this difference, the intervallar lattices, instead of being more or less horizontal in their outer half, as seen in radial section in *F. irregularis*, in this species have a more uniform, downly dipping curve, resembling in this respect *F. ptychophragma* (see our Memoir No. 2, Plate XIV, Fig. 67 A, lower part). In both these species the elements of the intervallar mesh average less than 1 mm. apart, about three to 2 mm. The inner wall is similar in both (see our Plate XIII, Fig. 64 D), the pores being about one to 1 mm. The intervallum coefficient is 3 mm. : 5 mm.

New Species *Flindersicyathus circliporus.*

The outer wall is of the same type as in *F. decipiens*, but the pores are definitely larger and are spaced three to 1 mm. The intervallar mesh is more open, the elements averaging a full mm. apart. The inner wall is more openly porous, the pore walls being narrower in proportion to the area of the pores, and the pores are more numerous in a given longitudinal distance, about three to 2 mm. See Plate XXVII, Fig. 110 A, 110 B. The outer wall shows shallow, wavy, transverse corrugations, and the intervallum coefficient is about 8 mm. : 12 mm.

New Species *Flindersicyathus tabulatus.*

In the details of its tissues this species closely resembles *F. decipiens.* The outer wall is similar, with pores four to 1 mm.; the intervallar mesh is similar, three elements to 2 mm., or a little coarser, one to 1 mm.; the inner wall is similar, with pores one to 1 mm. The special feature of the species is the presence of upwardly convex "growth tabulae"; these occur at irregular intervals, from 1 mm. to 10 mm. apart, and appear to indicate successive periods of growth of the sponge. At the end of such a period the cup was terminated by a convex porous wall, the following segment commencing with a narrower external diameter and expanding in its turn to a fresh convex termination. The species is shown on Plates XXVII, XXVIII, Figs. 111 A, etc. Fig 111 A shows the tabulae in tangential longitudinal section, with the same enlarged in Fig. 111 D. Fig. 111 E, F shows two views of a small terminated cup which is probably a comparatively young specimen of this species. The outer form of a mature specimen is that of a more or less cylindrical, externally corrugated tube. The intervallum coefficient is necessarily variable. In a fragment 8 cm. long it is 5 mm. : 5 mm. at the lower end, and 4 mm. : 13 mm. at the upper.

New Species *Flindersicyathus macdonnelli.*

The only specimen of this species from the MacDonnell Ranges in Central Australia is, like the rest of material from that locality, poorly preserved in a highly siliceous stone. The specimen is a short fragment of a cone about 20 mm. long, with an intervallum coefficient of 5 mm. : 4 mm. at the lower end, and of 7 mm. : 10 mm. at the upper end. The inner wall is of the type characteristic of the genus, with large pores, one : 1 mm., leading upwards and inwards. The intervallar tissue is only visible at two points, but is of similar character to other species of *Flindersicyathus.* The form is more conical than that of Ajax species. See Plate XXVIII, Figs. 112 A, B.

Genus *Sigmofungia.*

Taylor in 1910 described a species *Archaeofungia ajax,* his specimen being difficult to make out in all its details owing to secondary silicification. There appear to be two genera at the Ajax, either of which is more or less consistent with Taylor's figure and description. We have described these in previous memoirs as *Metafungia* and *Sigmofungia* (see our Plate IV, Fig. 23, and Plate XIX, Figs. 81, 82). We used the termination -fungia to relate the specimens to Taylor's, but are still undecided as to which of our two genera is actually "*Archaeofungia,*" Together with other points of difference, in *Sigmofungia* "the inner wall pores are in vertical rows, each pore being separated from those above and below it by a sigmoidally curved plate" (see our Memoir No. 2, p. 16). All these forms are extremely rare.

New Species *Sigmofungia fragilis.*

We have one fragment whose tissues are more delicate and on a finer scale than those of *S. flindersi,* the septa being $\frac{1}{2}$ mm. apart as against about 1 mm. in the latter, and the synapticulae finer and much more numerous. Sigmoidal plates are present in the inner wall pores. The intervallum coefficient appears to be about 4 mm. : 10 mm. Details are shown on Plate XXVIII, Fig. 114 A, B, and the relative dimensions may be compared with Fig. 113 (*Metafungia*) and Fig. 115, which shows another species of *Sigmofungia,* the three figures being drawn to the same scale.

New Species or Variety *Sigmofungia tabularis.*

We have found two specimens, agreeing in other respects with *Sigmofungia flindersi,* which show definite tabular structures. One of these specimens is shown in transverse/oblique section in Fig. 115. At the lower right corner is part of one tabula lying in the plane of the section, which is here transverse. The tabula is here seen to have an irregular structure of a coarse mesh whose interstices are occupied by a finer mesh. At the left hand of the figure the section becomes oblique, and another tabula is seen cut across; also here the sigmoid plates of the inner wall become visible. The intervallum coefficient is 5 mm. : 6 mm. The other specimen (not figured) shows, in tangential longitudinal section, five clearly-defined curved tabulae in a length of ten mm., and would at first sight be mistaken for a tangential section of a *Coscinocyathus.*

New Genus *Copleicyathus.*

The fragments on which this remarkable genus is based were found in the same small outcrop near the "Paint Mine," Beltana, in which *Beltanacyathus* occurs. A central cavity is present, at least in the upper part. Septa are numerous and are of "wire-netting" character; although they are in places traceable right across the intervallum, they are very irregular and more often curve and anastomose with neighboring septa. The inner wall is of very unusual type, being a thick, felted mass of curved anastomosing rods continuous outwardly with the septal mesh. The only species yet found is the genotype *C. confertus.* The form appears to be sufficiently distinctive to require a new family, *Copleicyathidae,* for its reception. The question of its ordinal relationship is deferred until a full revision can be attempted, but it may be placed provisionally with the *Metacyathina.*

New Species *Copleicyathus confertus.*

This conforms to the generic description just given; the intervallum coefficient of the type specimen is 4 mm. : 5 mm. The irregular septa are about $\frac{3}{4}$ mm. apart. The thickness of the mass of close-set felted fibres forming the inner wall is $1\frac{1}{2}$ mm., and we cannot make out any definite porous lamina in connection with it. The outer wall is obscured externally by secondary silicification; it seems to be a network of small irregular pores, but the preservation is too poor to make this certain. The type specimen is shown in transverse and longitudinal sections in Figs. 116 A, B; the latter section is tangential, grazing the outer surface of the mass of

fibres which forms the inner wall. The specimen shows on one surface a silicified mass outside the outer wall, figured in Figs. 116 C, D; at first we thought this might be exothecal tissue, but probably this is not so. Fig. 116 F shows a smaller variety in which the septa are more regularly radial. Fig. 116 E shows a small specimen, also from the same mass of rock, which might perhaps correspond to an early stage of *C. confertus*, but, of course, we have as yet no direct evidence as to the mode of growth of that species.

New Genus *Spirillicyathus*.

These are small forms from the "Paint Mine." In the genotype *S. tenuis* the outer wall has irregular pores, formed by anastomosis of the underlying septal elements (Fig. 118 C). The septa are built of a series of radial and longitudinal rods (Fig. 118 B, E) and are connected by tangential rods or "synapticulae." As seen in transverse section, the septa often run fairly straight from inner to outer wall, but they also often bifurcate and anastomose, particularly near the outer wall. The inner wall is a definite layer, with small circular pores, about two rows to the intersept. As far as we know the form grows from a spitz having essentially the same character.

New Species *Spirillicyathus tenuis*.

This has the characters above mentioned. The type specimen is insufficient to show the general shape, which is, perhaps, roughly cylindrical. The intervallum coefficient is $2\frac{1}{2}$ mm. : $1\frac{1}{2}$ mm., the central cavity being very narrow. The irregular septa are about $\frac{1}{2}$ mm. apart. Synapticulae are numerous. The specimen is shown in Figs. 118 B-E. A small spitz, shown in Fig. 118 A, is from the same mass of rock, and may, perhaps, be of this species.

New Species *Spirillicyathus pigmentum*.

The little specimen to which we give this name is also from the "Paint Mine" outcrop. It is a small cone (Fig. 117 A) having an intervallum coefficient of 2 mm. : 2 mm. at the upper end. It agrees with the former species in the character of the outer wall and in the anastomosing branching septa, and in the defined, porous inner wall. But in this species the inner wall pores are larger, with one row of pores to the intersept and the septa are rather in the form of porous laminae than of trabecular mesh. The septa are about 2/3 mm. apart. Synapticulae (if present) are not a regular feature. Figs. 117 B-E show details of the structure.

In using the generic name to cover these two rather dissimilar species, we are making a temporary convenience of it for the reception of these and other scarce and somewhat nondescript little forms whose relationship to better-known and commoner genera is not yet clear. The character of the outer wall and the irregular septa remove them from *Archaeocyathus* and related genera. The septa are too predominantly radial for *Protopharetra*, and the inner wall pores have not the specialised form of *Flindersicyathus*. There is no evidence that they grow from an *Archaeopharetra*-like spitz as do the Metacyathina and *Paranacyathus*.

New Species *Syringocnema spriggi*.

We are indebted to Mr. Reginald Sprigg, a student at the Adelaide University, for the specimens of this type, which he collected at Ardrossan, S.A. There are also probably other new species of Archaeos in material collected by Mr. Sprigg as well as by ourselves in that and other localities which we hope to deal with in a later paper. In the meantime it is interesting to record that Mr. Sprigg has found at Ardrossan a specimen of Taylor's species, *Dokidocyathus simplicissimus*, and that we note the occurrence there of *Bronchocyathus trachealis*. Some of the more aberrant forms from Ardrossan are referred to later in the present paper.

Syringocnema spriggi differs from the Ajax form *S. favus* (Taylor) by its long, narrow, cylindrical shape and its narrow intervallum. In a length of 50 mm. it varies little from a diameter of 10 mm., and an intervallum coefficient of 2 mm. : 6 mm.; whereas the Ajax species increases in 40 mm. length from a diameter of 17 mm. at the bottom to 25 mm. at the top, and has an intervallum coefficient of 6 mm. : 6 mm. The Ardrossan species is shown in Plate XXIX, Figs. 119 A-D; the plan of construction agrees with that of the Ajax species.

Order *METACYATHINA*.

Genus *Archaeopharetra*.

In our second paper we described and figured a small organism under the name of *Archaeopharetra typica*. We have since had the opportunity to examine a series of specimens of the same or similar character, and they yield results of considerable importance for the classification of the Pleospongia. It is highly probable that some or all of the varieties of *Archaeopharetra* are actually "spitzes" of members of the order Metacyathina, but until they can be definitely allocated to the relative adult forms the name *Archaeopharetra* may still be used for convenience. The outstanding feature of these spitzes is that they originate as minute conical tubes with transverse partitions; see Plates XXIX, XXX, particularly the lower parts of Figs. 120 A, 120 E, 123 A. We have not seen any pores either in the tube-wall or the partitions in these earliest stages. As the tube enlarges, straight or curved rods grow upwards and downwards from the transverse partitions and may either hang freely as straight or hooked processes or may pass as vertical connecting rods from one partition to the next; these rods are well seen in Figs. 120 C, D. An occasional pore occurs in the partitions at this stage; one such is present in the lowest partition of Fig. 120 C, though it is not seen in the drawing. The outer surface of the tube is often covered by a circularly striated coating, seen in Figs. 120 C, 121 A, 122 A, 123 A.

Archaeopharetra typica (Bedford, 1936).

The specimens shown in Figs 120 A-E resemble this species, though there are points of difference among them. Fig. 120 A seems to be quickly replacing its basal transversely partitioned structure by a coarse "*spirocyathus*"-like structure, without as yet any sign of an inner wall. Fig. 120 B retains its transverse par-

titions, but has, centrally, in the upper part a kind of crude, irregular inner wall.

New Species *Archaeopharetra tenuis.*

This form, which has a more delicate, crowded tissue, is shown in Figs. 121 A, B, C. A tangential section just within the wall shows a certain degree of orientation of the structural elements. There is no sign of an inner wall.

New Species *Archaeopharetra syrinx.*

This interesting modification is shown in Fig. 122 A, B. The more or less horizontal partitions are united by more or less vertical columns of perforated plates, forming a cellular structure with perforated dividing walls. This is possibly a spitz of "*Syringocnema.*"

Archaeopharetra sp.

The specimen shown in Fig. 123 A, B commences as a fine tube with the usual horizontal partitions and continues as a rapidly expanding cone, with development of trabecular tissue and change of orientation of the originally horizontal partitions. This is evidently the spitz of a form near *Metacyathus.*

"*Archaeopharetra*" and the Metacyathina.

The character of the "*Archaeopharetra*" spitz, differing entirely as it does from other Archaeo spitzes, is strong justification for the establishment of the Order Metacyathina; and present indications point to increase in the number of forms which may have to be included in this order. Among genera which have already been included in the order and whose inclusion is now receiving confirmation are *Metaldetes, Metacyathus,* and *Metacoscinus;* but there are also forms hitherto classed by us as "Spirocyathina" which may have to be included among the Metacyathina; one such is *Syringocnema,* and we have also seen fragments with an *Archaeopharetra*-like base passing upwards into an undetermined "*Spirocyathus*"-like cup. Further material is necessary to clear up the position as regards individual genera. On the other hand, it is quite clear that not all "Spirocyathina" have to be transferred to the Metacyathina; for example, we have recently found an excellently preserved specimen of *Protopharetra graphica* in which the minute spitz plainly shows the normal features of porous outer and inner walls connected by trabecular mesh.

In mature cups of the Metacyathina it would appear that the dissepiments, which are a frequent feature, have probably arisen by persistence, with changed orientation, of the horizontal partitions of the "*Archaeopharetra*" spitz. The trabecular structures, including septa, inner wall and synapticulae appear to have arisen from the vertical rods which begin to appear as growths on the partitions at a little distance above the spitz. Not all mature cups of Metacyathina show dissepiments; these for the most part are lost in the upper parts of *Metaldetes* and *Metacoscinus;* even in some specimens of "*Archaeopharetra*" such as that figured 120 A it will be noticed that the horizontal partitions are confined to the extreme spitz.

New Species *Metacyathus ramulosus.*

A well-preserved fragment of one of the Metacyathina is shown in Fig. 124 A, B. The presence of fairly numerous dissepiments corresponds to our definition of the genus *Metacyathus,* but the specimen does not quite coincide with either of the previously described species. It is more like the unnamed specimen figured in Plate V, Fig. 28, which we compared to *Metaldetes.* The fragment is of a large cup, 8 or more cm. diameter; the intervallum is 9 mm. The outer wall appears to be a coarse mesh with tubercules encroaching on and partly subdividing the "pores." The septa are a full mm. apart and have fairly uniform circular or oval pores, about 1/3 mm. diameter and three to 2 mm. Curved dissepiments are present. The inner wall, which is seen from the septal side in Fig. 124 A is a beautiful example of "compound reticular" structure, being composed of a coarse irregular mesh attached to the septa and bearing a fine reticular mesh on its inner face. We name it *M. ramulosus* from the character of the inner wall.

New Genus *Ardrossacyathus.*

The genus is founded on a single unsilicified fragment from Ardrossan to include Metacyathina with irregular outer wall, dissepiments, porous inner wall, and endothecal tissue showing a horizontal stratification reminiscent of *Archaeopharetra tenuis.* The genotype, *A. endotheca,* possesses straight septa of delicate open mesh.

New Species *Ardrossacyathus endotheca.*

The fragment indicates an intervallum coefficient 4 mm. : 5 mm. The outer wall appears to be irregularly porous. The septa are straight, a mm. apart, composed of a delicate mesh surrounding polygonal pores four to 1 mm. The inner wall is thin with rather irregular pores about four to 1 mm. The endothecal tissue is to a considerable extent aggregated to form curved transverse irregular sheets, running across the central cavity and spaced about ½ mm. apart. See Plates XXX, Fig. 125 A and XXXI, Fig. 125.

Compare *Ardrossacyathus.*

Another unsilicified fragment from Ardrossan is shown in oblique transverse section in Plate XXI, Fig. 126. If the tissue at the top left corner and lower left side of the sketch represents outer wall, it is very rugged and irregular. There is a definite porous inner wall and the central cavity is filled with endothecal tissue in layers resembling that of *Ardrossacyathus.* The intervallar tissue, however, is much more irregular than that of *A. endotheca.*

New Genus *Metaldetimorpha.*

We propose this generic name for some very obscure and shapeless fragments which are fairly frequent in the Ardrossan limestone; another obscure form occurs at the "Paint Mine," Beltana. Genotype, *M. yorkei.*

New Species *Metaldetimorpha yorkei.*

The type specimen of the Ardrossan form is shown in Plate XXXI, Figs. 127, 127 A, C, D, E. The stone containing the fossil shows four facets A, B, C, D, and enlargements of facets, A, C, D, are shown in Figs. 127 A, C, D; very little is visible on facet B. C shows a section which appears to be roughly transverse. A cavity appears in this section, but it is doubtful if this represents an actual inner wall and central cavity, and in none of the specimens can these structures be identified with certainty. At bb is a partial ring of thickened tissue forming a wall, and it is noteworthy that this is sandwiched between zones of trabecular tissue both externally and internally. At aa a defined plate or wall occurs and is seen on both facets A and B; this plate does not show obvious pores; the elements of the trabecular mesh anastomose with it. A second similar plate occurs on facet A. These plates do not correspondent in character with the porous wall bb previously referred to. A section of one of these plates is seen further enlarged in Fig. 127 E. If the outer surface is represented at the upper part of Fig. 127 A it has a very ragged character.

Another somewhat similar fragment is shown in Fig. 128. Here the tissue in the upper part of the figure has more of a septal appearance; near the bottom is a zone of parallel structures on a rather smaller scale; and between the two is a structure somewhat resembling the "wall" in the type specimen.

Another fragment, Fig. 129, has a zone of somewhat septa-like structures externally, and a zone rather like the endotheca of *Ardrossacyathus* internally, a kind of wall separating the two tissues.

Two further fragments are shown in Plate XLI, Figs. 159 A, B, C. One of these fragments is shown cut transversely in 159 A, and it is found that the right-hand lower edge of this figure corresponds to one of the wall-like structures such as occur at Fig. 127 Cab. This structure, seen in longitudinal section along the face of the wall in Fig. 159 B, has a regularity of structure which comes as rather a surprise considering the general irregularity of the organisms. It appears that the tissue near the wall has, in longitudinal section, a regular honeycomb structure and that the wall itself is formed by an oriented thickening of all the walls of the honey comb, thus encroaching on the lumina and forming a porous sheet, the pores of which become progressively smaller towards the centre of the sheet; each pore would thus have an hour-glass-shape as seen in transverse section of the organism. The second specimen, seen in transverse section in Fig. 159 C, presumably shows one of these "walls" taking a sinuous course through the middle of the section.

New Species *Metaldetimorpha flindersi.*

Obscure, poorly preserved and, for the most part, unsilicified fragments occur at the "Paint Mine," Beltana, which bear some resemblance to the last described species, and which we place in the same genus under the name *M. flindersi.* The type specimen is figured in Plates XXXII, XXXIII, Figs. 130 A—F. A view of a complete face of the fossil is seen in Fig. 130 A. In this three patches of septal structure occur, with intervening patches of trabecular structure; at the left of the section are two curved, more or less concentric, zones of trabecular tissue. Very little indication is seen of any defined symmetrical form. The septa are inconstant in their orientation, as is seen better in Fig. 130 B, which is taken from another face of the type specimen; they also vary in scale, reaching 1½ mm. or more apart in 130 B and under 1 mm. in 130 F; note the same feature in another fragment 130 G, where the coarse structure at the right contrasts with the finer structure at the left, and compare this with Fig. 128 of *M. yorkei,* with coarse structure above and fine below. Wall-like structures occur within the septal and trabecular tissue; one of these is seen in section at the middle left of Fig. 130 F, and in surface view at the top of the same figure; similar walls are seen in another fragment from the Paint Mine, Fig. 130 G, which may be compared with Fig. 159 C from Ardrossan. The concentric zones of trabecular tissue are shown in Figs. 130 C and D in transverse section, also in Fig. 130 E where the lower part of the tissue is running longitudinally.

The relationship of the zoned tissue to the remainder of the specimen is not yet clear; it may be an essential part of the organism, or it may be a parasitic growth such as we suggest the next described specimens to be under the name of *Exocyathus.* In Fig. 131 A, B is figured another fossil from the Paint Mine, in which zones of *Exocyathus-like* tissue form a joint coating to specimens of *Protopharetra* and *Beltanacyathus.*

Apart from the fact that none of the fragments we have so far found either at Ardrossan or the Paint Mine indicate any definite general shape, *Metaldetimorpha* has more resemblance to *Metacyathus taylori* than to any other Archaeo we have yet seen; and we have found at the Ajax one irregular specimen which at first we considered as a fragment of a large *Metacyathus taylori,* but which has points of resemblance to *Metaldetimorpha flindersi.*

New Genus *Exocyathus.*

One of the most difficult problems of the Archaeos is the true nature of the structures described by Taylor as "roots" and "exotheca." The great majority of Ajax specimens show no such structures, and, when a limited supply of material was available, and the structures appeared to be associated with one or two defined species such as *Archaeocyathus sellicksi,* it was natural to regard the structures as essential parts of the particular species. But we now find that these structures are of sporadic occurrence and are associated with a minority of the individual specimens of such widely separated types as *Protopharetra, Beltanacyathus, Metacoscinus, Archaeocyathus* and *Coscinocyathus.* Moreover the same band of investment may include within itself two or more totally different Archaeos, and then appears equally connected and related to each of the included organisms. Although the matter cannot yet be regarded as decided, the evidence appears rather to point to the

structures referred to as being a parasitic investment; and we propose the generic name *Exocyathus* for that type of investment which occurs in well preserved detail at the Ajax Mine, and also in other South Australian localities. The genotype is *Exocyathus australis*. Various specimens are shown on Plates XXXIII to XXXV, Figs. 132-136. The tissue of *Exocyathus* consists in the main of a series of obliquely vertical lamellae, which radiate from the Archaeo wall to which they are attached, and which, in a fully developed specimen, are arranged in a number of concentric zones. Under favorable conditions the tissue can be traced downwards into a small cylindrical body or bodies of very characteristic structure, shown in Fig. 132. These cylindrical bodies may be termed either "spitzes" or "roots" according as they are regarded as the first or the last stages in formation of the *Exocyathus*. If the structure is regarded as "Exotheca," and also if it is regarded as a parasite commencing as an outgrowth from the Archaeo, then these cylindrical bodies are distal "roots"; if, on the other hand, it is regarded as originating freely and becoming attached later as a parasite to the Archaeo, then the cylindrical bodies are proximal "spitzes." It is impossible to be sure of this; a small specimen such as Fig. 132 A, B gives the impression of a spitz, but a spitz of very unusual kind, different from that of other groups of Archaeos; on the other hand Fig. 135 A and 146 A, both of which show *Exocyathus* surrounding the bases of species of *Archaeocyathus* suggest that the cylindrical bodies are distal outgrowths from the zoned laminar masses.

We make the provisional suggestion that the small cylindrical form Fig. 132 A, B is the spitz of *Exocyathus*, that in course of growth the organism attaches itself parasitically to various species of Archaeo, spreads in concentric zones Fig. 136 A and may give rise to more or less cylindrical outgrowths Fig. 135 A, 146 A. If this suggestion can be substantiated, it is clear that the spitz is of a different construction from those found in other orders of Archaeos and may place *Exocyathus* in a separate ordere.

The question of the relationship of the various zoned and parasitic Archaeos is a very difficult one. Unless structures are very definite, the correlation of silicified and unsilicified material is not easy. All one can say at present is that parasitism is suggested in the South Australian *Exocyathus* and that the form described by us in 1926 as *Ajacia* as a supposed Alga may be another parasitic Archaeo, Plate VII, Fig. 37; also in Vologdin's Siberian genus. *Labyrinthomorpha;* also in the zoned outer tissue of the Canadian *Archaeocyathus profundus*. Zoned tissue is found in an irregular form in the South Australian *Metacyathus taylori*, and *Metaldetimorpha*, and in more or less regular concentric zones in the South Australian *Exocyathus* and the outer tissue of the Canadian *A. profundus* (see Bornemann's photograph). As regards structural indications of affinity *Exocyathus*, with its very distinctive "spitz," appears quite different from *Metaldetimorpha*, which one is inclined to relate to the Metacyathina; but the Paint Mine *Metaldetimorpha* is associated with zones having a resemblance to *Exocyathus* (see Fig. 130 A, C, D, E. Bornemann's photograph of *A. profundus* has most resemblance to the zoned tissue of the Paint Mine. Two questions which may be asked are: is the Paint Mine form a *Metaldetimorpha* or *Metaldetimorpha* plus *Exocyathus?* and: is Bornemann's photograph a *Spirocyathus* plus *Exocyathus* or *Spirocyathus* plus *Metaldetimorpha?* There is also another alternative, viz., that our *Protopharetra furca* Figs. 106 and 131, and the *A. profundus* photographed by Bornemann are definite organisms with a *Protopharetra*-like centre, surrounded by concentric zones of tissue; if this be so, they would appear to be related to *Metacyathus taylori* and *Metaldetimorpha;* but this does not seem to correlate them with the peculiar "spitz" structure of *Exocyathus*, and appears to hint at two distinct lines of development leading to zoned structure in Archaeos; if *P. furca* is individually one with its zoned surrounding tissue, then this tissue has a tendency to incorporate itself with or to parasitise other species Figs 106 A, 131 A.

New Species *Exocyathus australis*.

The Ajax variety of this species occurs as silicified cylindrical spitz-like fragments, Fig. 132, and as concentric zones of laminar structure surrounding various species of Archaeos, Fig. 133, which often give off root-like bundles Fig. 146 A. The smallest specimens Fig. 132 A, B consist outwardly of a close set series of vertical rods, spaced about five to two mm.; adjacent rods are connected by small and numerous cross-bars, thus constituting a kind of porous wall which differs markedly from that met with in any other group of Archaeos. Many of the rods are produced inwardly as lamellae which are elongated lengthways and which anastomose towards the centre to form long, irregular pipes. In somewhat larger specimens Fig. 132 C, the structure is more markedly lamellar and less rod-like; and in still larger specimens the lamellae commence to have a zonal arrangement, Fig. 132 D. Fig. 133 A shows a transverse section of the lamellar structure, in two zones, attached to the outer wall of an *Archaeocyathuss aequisemis;* the intimate relation of the structures, and the continuity of the wall pores of the Archaeo with the spaces of the *Exocyathus* are noticeable. Fig. 133 B shows a longitudinal view of the attachment in the same specimen. Fig. 133 C, from the same specimen, gives a longitudinal section of the lamellar structure passing outward into a bundle similar to those shown in Fig. 146 A, and Fig. 133 D shows a transverse section taken across A A in Fig. 133 C. In Fig. 134 A, B is seen a specimen of *Metacoscinus reteseptatum*, with a growth on the outer wall consisting of a kind of concentric "smear" of pellis-like tissue (a) within which are small *Exocyathus*-like lamellae (b).

The variety of *Exocyathus australis* which occurs at Ardrossan has rather a finer texture, the laminae being three or four to 1 mm. The material here is unsilicified, but is excellently preserved. Fig. 135 A shows a transverse section of *Exocyathus* completely surround-

ing the base of a specimen of *Coscinocyathus australis*. Two concentric zones of lamellar tissue are visible, together with a number of root-like columnar outgrowths. Fig. 135 B shows details of the same specimen.

Fig. 136 A, C, Plates XXXIV, XXXV, shows an *Exocyathus* from Carrickalinga Head, S. Aus. We are indebted to Mr. Sprigg for the specimens from this locality. The transverse section, 136 A, B, shows several irregular zones of lamellar tissue surrounding an unidentified Archaeo which shows septa, dissepiments and endothecal tissue. At A is seen a flat septate plate whose relation to the rest of the fossil is difficult to determine. Details of the specimen are given in Fig. 136 B, Plate XXXV. Another Carrickalinga specimen shows *Exocyathus* forming a joint investment to a *Protopharetra*-like form and a delicate *Coscinocyathus*.

Genus *Paranacyathus* (*Paracyathus*, Bedford 1936).

In our second paper we described under the generic name *Paracyathus* a "small conical form in which the base is filled with irregular trabecular tissue without inner wall or septa, the outer wall having small irregular pores; within a short distance of the base clearly defined radial septa, inner wall and central cavity appear, and the small irregular outer wall pores are replaced by large and regular pores." Owing to pre-occupation of the name *Paracyathus* we wish to alter it to *Paranacyathus*. Owing to the irregular base we placed this in the family *Metacyathidae;* the genus differs from *Metaldetes, Metacyathus* and *Metacoscinus* in that either outer or inner wall or both has regular simple pores in linear rows, whereas, in the other three genera, both walls are of irregular compound reticular type. We have since found additional specimens and also four other species which agree more or less with the characters of *Paranacyathus*.

Parancyathus parvus, Bedford, 1936.

Additional specimens of this, the genotype, are figured in Plate XXXV, Fig. 137 A, G. The form is conical; intervallum coefficient of upper part 3 mm.: 9 mm. Septa about 2/3 mm. apart; outer wall pores in a single row in each intersept, about four to 1 mm. vertically; inner wall pores for the most part apparently one row in each intersept; septal pores small and numerous. In one specimen dissepiments are present, Fig. 137 G.

New Species *Paranacyathus margarita.*

Several fragments of this species have been found and are figured in Plates XXXV, XXXVI, Fig. 138 A—K. From an irregular cylindrical *Archaeopharetra*-like spitz Fig. 133 C is formed a small, rapidly expanding cone 138 A, and this enlarges above into a large delicate bowl 138 D, which may become so much convoluted that the outer wall lies within the curve of the inner wall, 138 G. The circularly striated "pellis" on the spitz (middle of Fig. 138 C) is often found on spitzes of the metacyathina. The intervallum is narrow, only about 1½ mm, and the largest fragment found indicates a diameter of 10 cm. or more for the expanded rim. The septa are only ½ mm. apart, and numerous dissepiments may be present, 138 D. E. F. Both walls are very characteristic. The outer wall has a single row of pores to each intersept and each pore is covered externally by a little stirrup shaped cap, 138 H; occasionally these caps coalesce vertically to form stapiporous longitudinal ridges, 138 J. The inner wall has a single row of stirrup-pores in the line of each septum, and semilunar projections are present on the inner surface and may coalesce as horizontal ridges 138 I. One large fragment, in which the inner wall is for the most part normal, becomes more irregular in places 138 K. Septal pores are absent, except for the stirrup pores at the inner wall 138 F.

New Species *Paranacyathus regularis.*

This is a very scarce species; we have only found three small fragments of the expanded upper part. The lower part has not been seen, but it is placed provisionally in this genus because of the general resemblance of wall and septal pores to the three species next described and because of the presence of dissepiments in one specimen. It is figured in 139 A—E. The intervallum is narrow, 2 mm. The outer wall has pores regularly arranged, three to 1 mm., in two or three rows to the intersept. The inner wall has a single row of large pores to the intersept, the pores are rather wider than they are deep and are five to 2 mm. vertically, three to 2 mm. horizontally. The fragments are not sufficiently complete to be sure which is outer and which inner wall. The septal pores are large, oval and very irregular in size.

New Species *Paranacyathus grandis.*

Only one fragment has been found, Fig. 140 A—D. The form is nearly cylindrical, about 22 mm. diameter; intervallum coefficient 7 mm.: 8 mm. The outer wall is thick, rugged and irregular, with irregular pores averaging four to 3 mm. The inner wall pores are regularly arranged in a single row to the intersept, three to 2 mm. The septa are nearly 1½ mm. apart near the outer wall and have large irregular oval pores. Although the spitz has not been found, the species is placed with the Metacyathina on account of the irregular outer wall, and the large irregular septal pores, and in the genus *Paranacyathus* on account of the regularly porous inner wall.

New Species *Paranacyathus cortex.*

Only one fragment has been found. The spitz has not been seen and it is placed in this genus for the same reasons as given with *P. grandis*. The outer wall is rugged, but the ridges are finer, more regular and predominantly vertical. The outer wall pores average three rows to the intersept and five to 2 mm. The shape appears to be cylindrical; intervallum coefficient 3½ mm; 12 mm. The septa are 1½ mm. apart. The inner wall is thick, with a single row of regular and widely spaced pores to the intersept. Septal pores are large and irregular. See Figs. 141 A—C.

Paranacyathus magnipora (=*Archaeocyathus magnipora* Bedford, 1934.)

Fresh material of this species (see Memoir No. 1, p. 2, Fig. 7), shows that it grows from an irregular, *Archaeopharetra*-like spitz; see Plate XXXVI., Fig. 142 A. Sketches of the upper part of the same and two other specimens are given in Plate XXXVII, Figs. 142 B—E. Larger fragments of this species indicate a conical tube reaching about 15 mm. diameter in a length of about 15 cm. The structure indicates transferring the species to the genus *Paranacyathus*. As will be seen by comparing the six species just described, there is considerable divergence of detail; in particular the three last mentioned species differ from the first three, and agree among themselves, in possessing large irregular septal pores; in this feature they resemble the Metacyathine genera *Metacyathus* and *Metaldetes*.

A Note on *Archaeocyathus floreus* (Bedford, 1934).

Since we first described this species, further material found has introduced complications which are difficult to clear up. Of ten spitzes six show an abnormal, irregular structure; two of these are figured 143 A, B. The first shows reduction of septa and development of irregular dissepimental tissue; possibly this is the result of injury and repair. The second, together with four others not figured show normal septa, but considerable development of dissepimental tissue. On the other hand four of the spitzes are normal in all respects, with little or no dissepimental tissue. In the smallest spitz seen, which is normal in other respects, the lowest section shows the septa united centrally, with disappearance of central cavity.

Among the larger specimens, which we have taken as being *A. floreus*, two distinct arrangements of septal pores occur. In one the septal pores are confined to a single row close to the outer wall; in the other they are in three or four rows regularly distributed through the whole width of the septum.

We have also found at the Ajax four specimens which agree in all respects with *A. floreus* except that the flutings, which give the characteristic flower-like transverse section, are absent. One of these gives just a slight fluting in places; one specimen shows the single row of septal pores; another shows the distributed septal pores.

In unsilicified material from Ardrossan we have found two small specimens, Fig. 144 A, B, which have considerable resemblance to *A. floreus*, although the outer wall pores, which in *A. floreus* are very distinctive, are not visible, nor do flutings appear to be present. Both these specimens show dissepiments. In these Ardrossan forms, the septa, though widely spaced, are much closer than in *A. floreus;* consequently the inner wall pores are in a single row to the intersept, whereas, in *A. floreus*, though this occaiosnally occurs near the spitz, there are usually two, three or more rows to the intersept in larger specimens.

Order *ARCHAEOCYATHINA* (Okulitch, 1935).

Species *Archaeocyathus subacutus* (Bedford, 1934).

On Plate XXXVII, Fig. 145 A—D is shown some fresh material to illustrate points not clear in our original specimens. Fig. 145 D is a small spitz, the typical structure continuing to a diameter of little over 1 mm. Fig. 145 A is a fragment of the upper part of a large delicate expanded specimen. Fig. 145 B confirms our surmise that septal pores are confined to a single row of small pores just within the outer wall.

New Species *Archaeocyathus aequisemis*.

This is a scarce conical stoutly built form. The type specimen is surrounded at the base by a mass of the tissue described earlier in the present paper as *Exocyathus* (q.v.):—See Plate XXXVIII, Fig. 146 A. The central cavity in the base is also partly filled with endothecal tissue. The intervallum coefficient is about 3 mm.: 20 mm. The pores of both walls average two to 1 mm.; hence the name. In both walls the pores are regularly arranged in quincunx and in regular vertical rows, avering three rows to the intersept. There is a strong tendency at the outer surface of the inner wall to formation of vertical ridges between the rows of pores, Fig. 146 E. The septa are stout, a full mm. apart, and are usually thickened towards the walls, particularly the inner wall; septal pores are small, in about six rows, and no stirrup pores are present. Fig. 146 F.

New Species *Archaeocyathus aequitriens*.

The type Fig. 147 A is practically the only branched Archaeo specimen which we have been able to grind out from the matrix. The intervallum coefficient of one of the branches is 2 mm.: 12 mm. In both walls the pores are regularly arranged in quincunx and average three to 1 mm. (whence the name). The pores average two or three rows to the intersept. The septa are about $\frac{1}{2}$ mm. apart and, over the width of the septum, pores are few and irregularly distributed; but, at the junction with the inner wall, stirrup pores are invariably present, Fig. 147 D. E; the inner wall thus has a row of stirrup pores in the line of the septum with one or two further rows of pores within the intersept, agreeing in this respect with *A. ajax*. Fragments of large expanded cups of this species have been found. In two of these fragments abrupt change of direction of the septa is noticeable Fig. 147 F, G, H. One of these specimens shows curious branched ridges of the outer wall surface, Fig. 147 F, I; from the relationship of these to the pores they appear to be part of the wall structure.

New Species *Archaeocyathus endothecalis*.

This is a scarce, stoutly-built, conical form (Fig. 148 A). The intervallum coefficient is $2\frac{1}{2}$ mm. : 10 mm. The central cavity in the lower part is filled with coarse endothecal tissue (Fig. 148 B). The outer wall pores are regularly arranged, polygonal, and closely set, about three to 1 mm. The septa are $1\frac{1}{2}$ mm. apart; no septal pores are present at all, with the exception of stirrup pores, which are always present at the inner wall, and which, at least in one specimen, are equally

marked at the outer wall (Fig. 148 E). The inner wall is similar to the outer. In both walls about four or five rows of pores are present in each intersept.

New Species *Archaeocyathus brunhilda.*

Only one specimen has been found (Fig. 149 A). It is conical, with intervallum coefficient 2½ mm. : 10 mm. The species, in many details, resemble *A. floreus*, but the septa are much closer and the outer wall is not bulged outwards in the intersepts. The outer wall pores are in separate clearly-defined vertical rows about 1/3 mm. apart, with slight vertical ridges between the rows (Fig. 149 C). The septa are about 1 mm. apart, and 48 are present in the specimen; (in *A. floreus* there would only be a dozen in a specimen of similar size); septal pores are confined to a single row of large pores close to the outer wall (Fig. 149 E). The inner wall is a stout structure with large, fairly regular pores, well separated from their neighbors; no stirrup pores are present; there is either one or else two alterating rows of pores to the intersept, and occasionally the place of a single pore is taken by a close pair of smaller pores (Fig. 149 D); the inner surface of the wall is somewhat wrinkled.

New Species *Archaeocyathus carmen.*

The only specimen found is a small cone with bulging wall (Fig. 150A). The intervallum coefficient is 1 mm. : 2½ mm. The outer wall has extremely minute pores regularly arranged in vertical rows; there are about eight of these rows to the mm., and low vertical ridges project between the rows (Fig. 150 C). Hardly any other Archaeo has been seen with such minute wall pores. The septa are close, hardly ½ mm. apart. The inner wall is rather a complex structure with horizontal bars and stirrup pores at the inner ends of the septa (Fig. 150 B, D); the structure somewhat resembles *A. retezona.* The material is too small for further dissection to see if any further septal pores are present.

New Species *Archaeocyathus josephina.*

Only one fragment ha been found (Fig. 151 A, B); it is a minute conical form with an intervallum coefficient 1 mm. : 2 mm. The septa are remote, about 1 mm. apart. The outer wall appears to have comparatively large pores, but is not well seen. The inner wall is very characteristic, as seen from the inner surface, the pores being arranged in regular horizontal rings, four to 1 mm., with small anular shelves between. The wide intersepts (and the ? large outer wall pores) at once distinguish it from *B. trachealis.*

New Species *Archaeocyathus divaricatus.*

The single fragment from which this species is described was found after the present plates were finished, so it is not figured here. It is a nearly flat fragment of a large bowl; the intervallum width is 3 mm. and the septa are ½ mm .apart The wall, which appears to be outer, has fairly regular pores, three to 1 mm.; most of the intersepts have two rows with alternating pores, but often the pores are in horizontal pairs, and often, by disappearance of the mid wall of such pairs, single wide pores are seen; above each pore is a little semi-lunar ridge (convex above), giving a nutmeg-greater appearance. The inner wall has a single row of wide polygonal pores filling the whole width of each intersept. The most distinctive feature of the species is the septal pores, which are in about eight divergent rows in each septum; the inner and outer rows regularly incline to and disappear in their respective walls and fresh rows appear near the centre of the septum. The septa are very porous and the arrangement of the pores is very marked, more so than in the only other Archaeo in which we have observed it, viz., *Sigmocyathus didymoteichus* (see Plate XXII, Fig. 93 B). The taxonomic value of this feature deserves consideration.

New Genus *Cadniacyathus.*

Archaeocyathina with vertical flutes to the outer surface, the furrows corresponding to the positions of the septa; the inner wall with scale-like hooks projecting upwards and inwards into the central cavity. Cadnia is a place name near Beltana. The genotype is *C. asperatus.*

New Species *Cadniacyathus asperatus.*

Two well-preserved fragments have been found. The form is conical (Fig. 152 A); intervallum coefficient 3 mm. : 13 mm. The septa average about 1 mm. apart, or 1½ mm. at the outer wall, where the flutings correspond. Four or five fairly regular vertical rows of outer wall pores are present to each intersept; pores about four to 1 mm. (Fig. 152 C). The inner wall pores are larger, two or three to 1 mm., usually in three alternating rows to the intersept; between each pore and the one above or below it is a jagged plate projecting upwards and inwards into the central cavity (Fig. 152 D, E). Septal pores are in about seven rows through the width of the septum (Fig. 152 E).

New Genus *Zonacyathus.*

Species *Zonacyathus retevallum* (equal. *Archaeocyathus retevallum*, Bedford, 1934).

Archaeocyathina with fine regularly arranged outer wall pores, closely set porous septa and an inner wall consisting of a reticular mesh of considerable thickness without a defined porous lamina. The genotype is *Zonacyathus retevallum* (described as *Archaeocyathus retevallum*, Bedford, 1934). The reason for separating this generically from *Archaeocyathus retezona*, Taylor, 1910, which possesses a reticular mesh at the inner wall and might be considered for inclusion in the new genus, is that *A. retezona* has, as the inner component of its inner wall, a regular porous lamina just like the inner wall of *A. ajax;* we have found specimens intermediate between these two species, specimens which may perhaps be regarded as hybrids, and therefore consider *A. retezona* and *A. ajax* as closely related, and consider the net-zone of the former as a development of the stirrup pores of the latter. *Zonacyathus retevallum* is considered to be a quite different type from either of the above. In

Plate XL, Fig. 153A-E, are illustrations of fresh material of *Z. retevallum* showing more detail than the original Figure 6; the original description gave the outer wall pores as a single row to the intersept, we now find a double row to be at least equally common.

Ethmocyathus lineatus (Bedford, 1934).

In Plate XL, Fig. 154 A-E, are shown details of additional material of this very scarce and interesting little species.

New Species *Coscinocyathus minimiporus.*

This is a very scarce, rather stoutly-built little conical *Coscinocyathus.* The outer wall has a quite regular series of pits, about four to 1 mm., bordered by more or less crescentic projections; within each pit is a lamina perforated by about half a dozen very minute pores (Fig. 155C). The intervallum coefficient is 2 mm. : 4 mm. The septa are $\frac{1}{2}$ mm. apart and, on an average, there are three alternating rows of the outer wall pits to the intersept. The septal pores are in about ten very regular vertical rows of very minute pores to each septum. The inner wall pores are three or four to 1 mm. and hooks are present projecting into the central cavity; one or two rows of inner wall pores are present in each intersept (Fig. 155 B, D). Tabulae are fairly regular, averaging $1\frac{1}{2}$ mm. apart; tabular pores are numerous and are excessively minute, about sixteen to 1 mm. (Fig. 155 B).

New Species *Coscinocyathus sylvia.*

Only one fragment has been found of this little *Coscinocyathus,* which is of unusual type. The intervallum coefficient is $1\frac{1}{2}$ mm. : 7 mm. The outer wall has pores which are in pairs, a pair occupying the width of an intersept (Fig. 156 B, lower part); projecting outwards from the wall are ridges which enclose the pairs of pores, and which are produced into papillae (Fig. 156 B, upper part). About four of these pore-pairs are present to 1 mm. of length. The septa are closely set, $\frac{1}{2}$ mm. apart, and about five rows of pores are present in the width of the septum. The inner wall has a single row of pores to the intersept; two or three pores to 1 mm. Tabulae appear to be about 2 mm. apart, with pores about eight to 1 mm.

New Genus *Polycoscinus.*

The genus is formed for the reception of two meandering, branching *Coscinocyathus*-like forms from the "Paint Mine." The genotype is *Polycoscinus contortum.* Vologdin has given the name *Polycyathus* to *Archaeocyathus*-like forms of similar habit from Siberia.

New Species *Polycoscinus contortum.*

A meandering, branching form with intervallum width of $2\frac{1}{2}$ mm. (Fig. 157 A). The outer wall has slight vertical flutes between the septa, and also slight horizontal corrugations about 1 mm. apart (Fig. 157 B). Septa average a full mm. apart. Outer wall pores, about five to 1 mm., are regularly arranged in about four vertical rows to the intersept; in our specimen they are covered externally by a uniform very finely porous pellis (upper part of Fig. 157 C); we have not seen precisely this feature in any other Archaeo. Inner wall pores, about four to 1 mm., average three vertical rows to the intersept, and vertical ridges are present on the inner surface of the wall between the rows of pores. Septal pores average six vertical rows in each septum. Tabulae occur at rather wide intervals.

New Species *Polycoscinus complexum.*

The species (Fig. 158 A, B) is of similar form to that last described, but is on a smaller scale, having an intervallum width of 1 to $1\frac{1}{2}$ mm., and septa $\frac{3}{4}$ mm. apart.

A NOTE ON THE CLASSIFICATION OF PLEOSPONGIA.

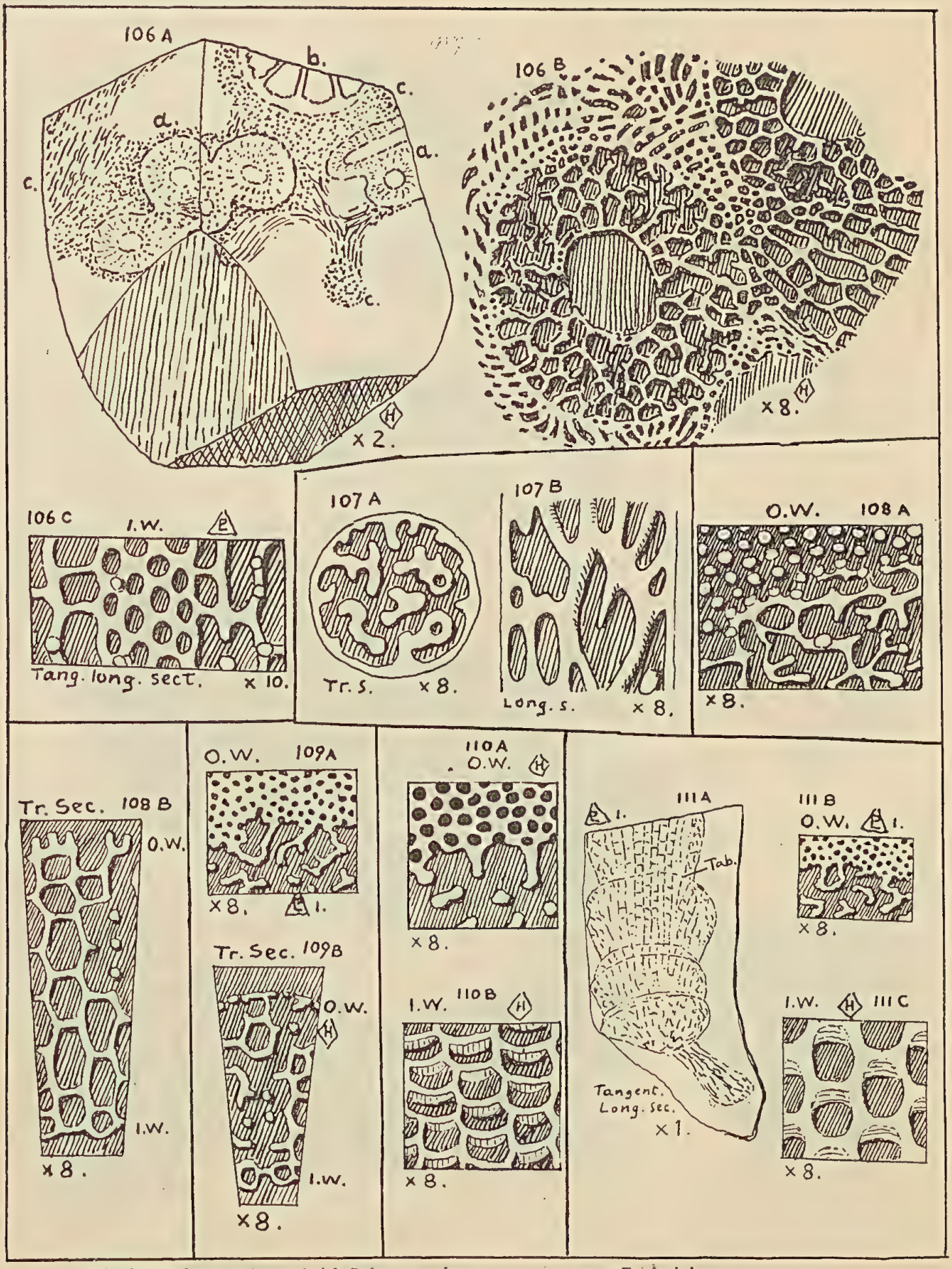
Among the Lower Cambrian sponges of South Australia the following structural types may be distinguished:—

1. Blastula and gastrula-like forms, spherical or oval in shape, having either a single or double wall of large spicular elements: described by us as *Uranosphaera.* In the gastrula-like, double-walled specimens we have not yet seen bars connecting the two walls; but isolated spicules, having six rays in one plane (or concave surface) and another ray perpendicular to these, suggest such a form with connecting bars.
2. Double-walled forms with connecting bars between the walls; the walls consisting of perforated plates to which are anachylosed radiating spicular elements. The generic name is *Hetairacyathus,* in substitution for the previously appropriated "*Heterocyathus.*" Dr. Okulitch gave this group ordinal rank as an order of the Pleospongia. Since our original description was published, a fresh fragment indicates that the general form may be that of a gastrula-like ovoid. Should this prove to be the case the general form relates *Hetairacyathus* to *Uranosphaera* rather than to the remainder of the Pleospongia, all of which grow from a conical spitz. If all these forms are to be included in the Pleospongia, one or probably both of the orders Uranosphaerina and Hetairacyathina are sharply distinguished by their mode of growth from the remainder of the class.
3. Order Monocyathina (Okulitch). These single-walled, conical forms present considerable differences of structure among themselves; e.g., *Monocyathus irregularis,* with sparse, irregular pores, each in the form of a pustule; *M. porosus,* with very regular pores, strongly resembling one of the walls of a regular *Archaeocyathus; M. spinosus,* with a more open mesh, and with little spines projecting outwards from the nodes of the mesh.
4. Order Spirocyathina (Bedford) (though the name may have to be abandoned, as suggested by Dr. Okulitch; if so, perhaps the name Dictyocyanthina will best express the relationship).

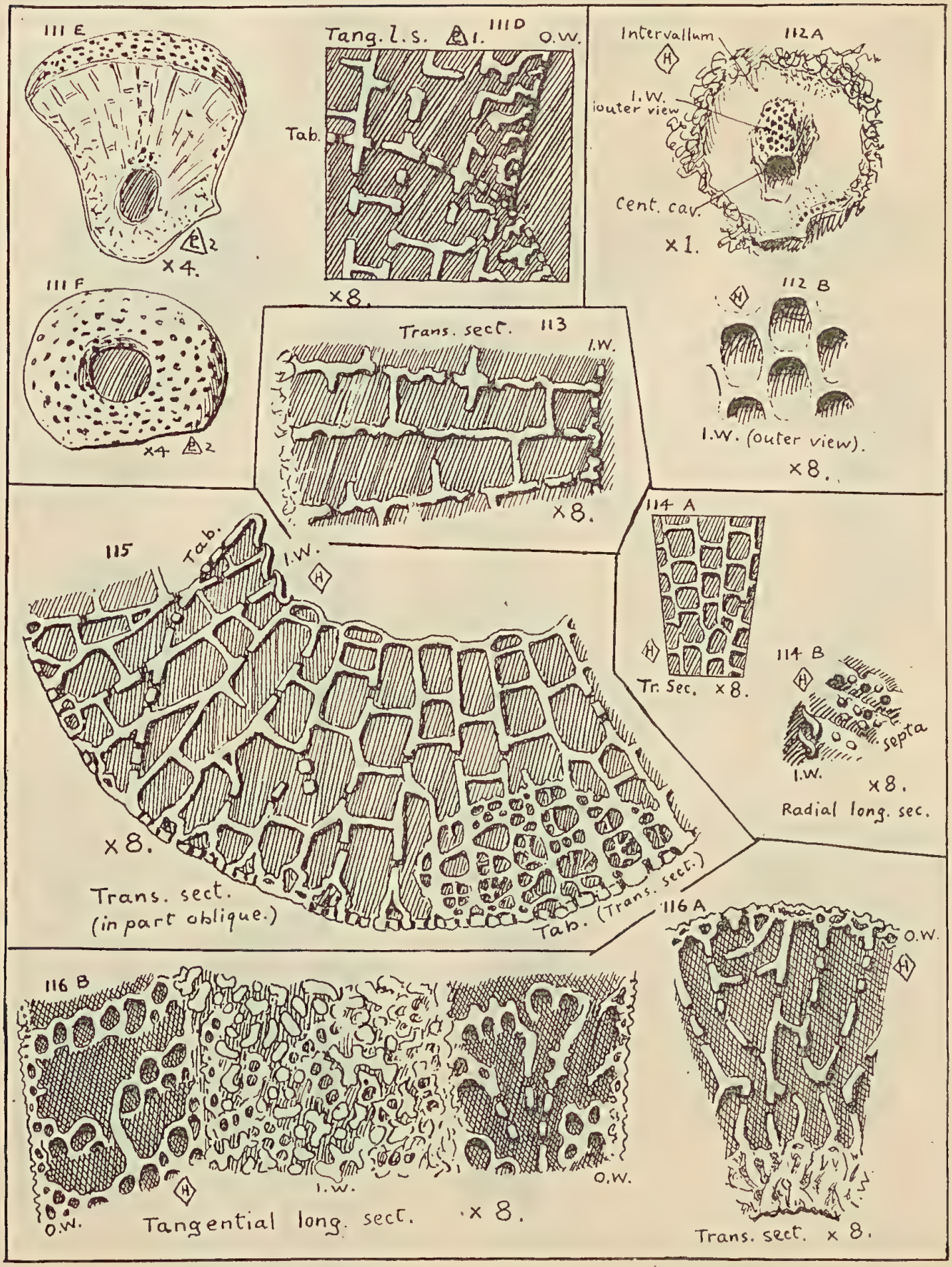
Members of this group grow from a conical spitz with two porous walls united by radial bars. The more highly developed forms show, in their upper parts, replacement of the simple radial bars by a trabecular mesh. Our recent results indicate transference of several species from this to the next following order; but further research is needed before the position of numerous species can be decided. Among forms which appear definitely to belong to this order are the various species of *Dictyocyathus* and the species *Protopharetra graphica.*

5. Order Metacyathina (Bedford). The discovery of the spitzes of this order, in the form of a small conical tube with *transverse* partitions, is referred to in the present Memoir. As the tube enlarges, rod-like processes grow from the partitions, and, later, the partitions appear to give rise to "dissepiments" and the rods to trabecular tissue. In the most characteristic members of the Metacyathina, such as the genera *Metacyathus*, *Metaldetes*, and *Metacoscinus*, whilst the basal portions have the above-mentioned trabecular and disepimental structure, without inner wall or central cavity; the upper portions develop inner wall and central cavity and the irregular trabecular tissue gives rise to clearly-defined radial septa. Besides the above-named genera, *Syringocnema* is found to grow from a spitz of similar character, and it is quite possible that some species hitherto referred to "Spirocyathidae" may be members of this order. Present indications point to the order being more extensive and important than was at first suspected. Among genera which are perhaps members of the Metacyathina, but as to which further investigation is necessary, may be mentioned *Paranacyathus*, *Paracoscinus*, *Pycnoidocoscinus*, *Ardrossacyathus*, *Metaldetimorpha.* It appears to be definitely ascertained that regular septate cups may arise from two entirely different types of spitz, and this fact makes satisfactory classification very difficult. The position of *Exocyathus* is not yet clear.

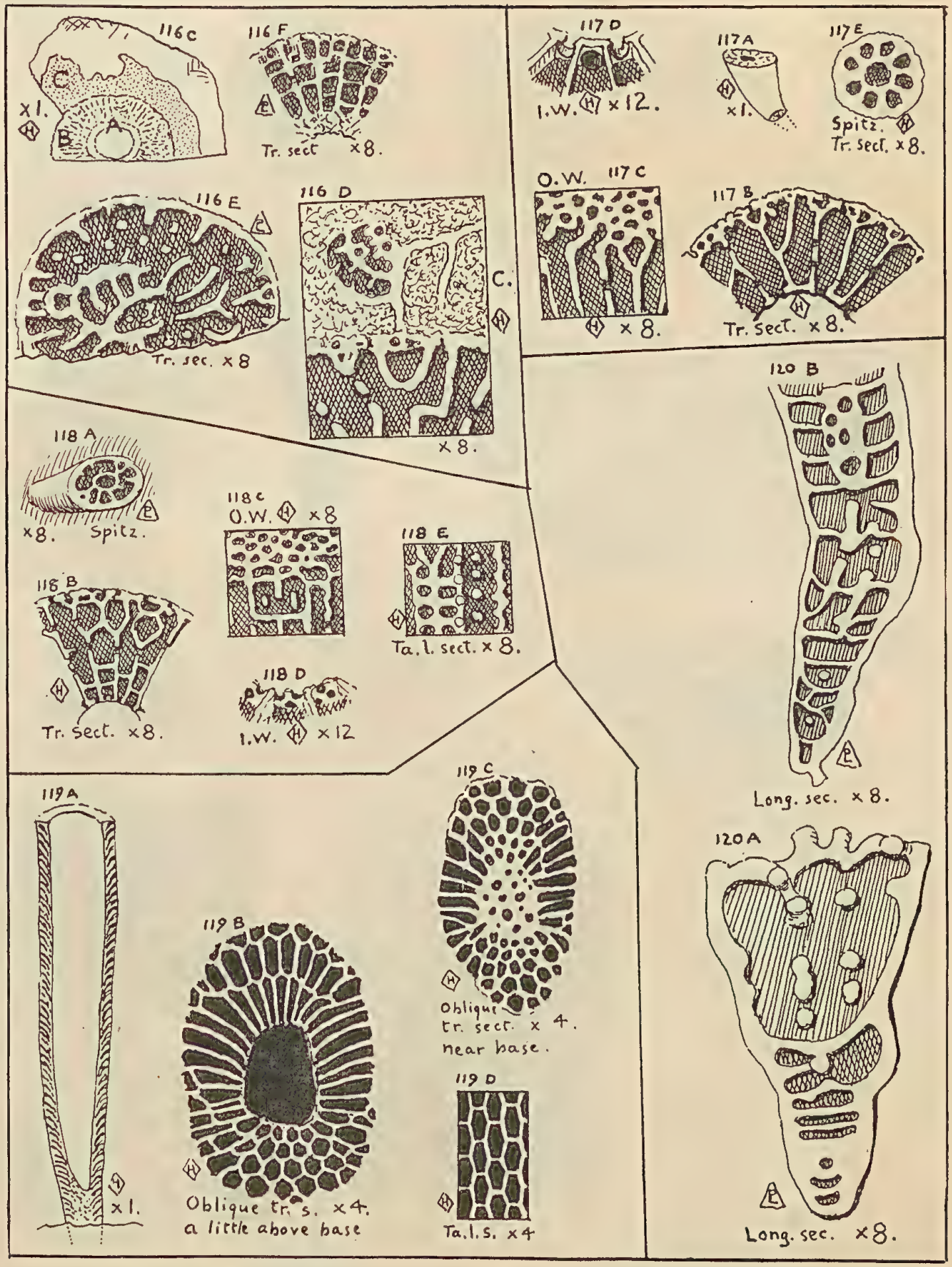
6. Order "Archaeocyathina." The spitz, whilst still quite small, shows porous outer and inner walls, united by straight, porous, radial septa. Typical genera are "*Archaeocyathus*," *Bronchocyathus*, and *Coscinocyathus.*



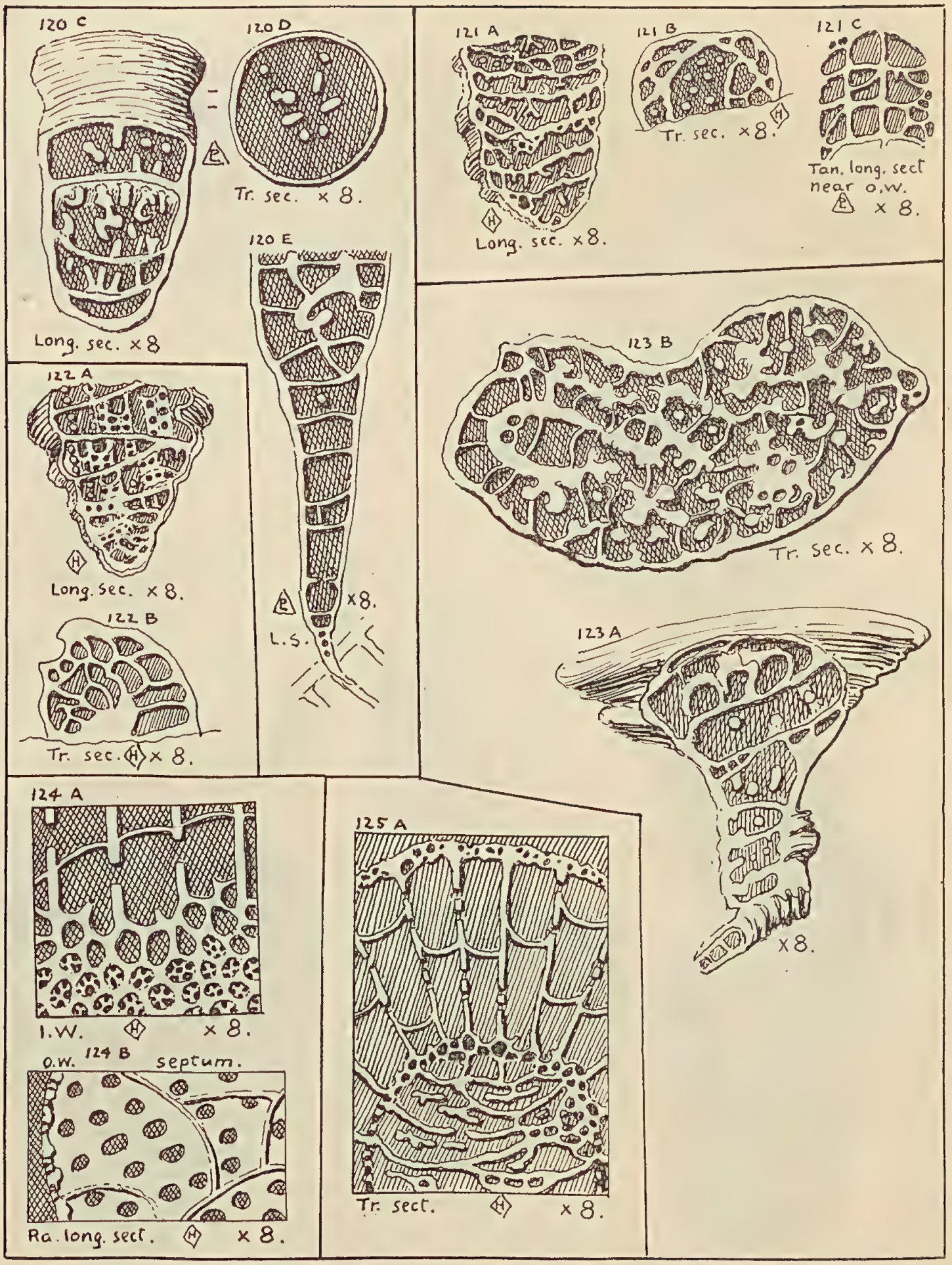
106. Protopharetra furca (with Beltanacyathus and Exocyathus).
107. Protopharetra radix.
108. Flindersicyathus irregularis.
109. F. decipiens.
110. F. circliporus.
111. F. tabulatus.



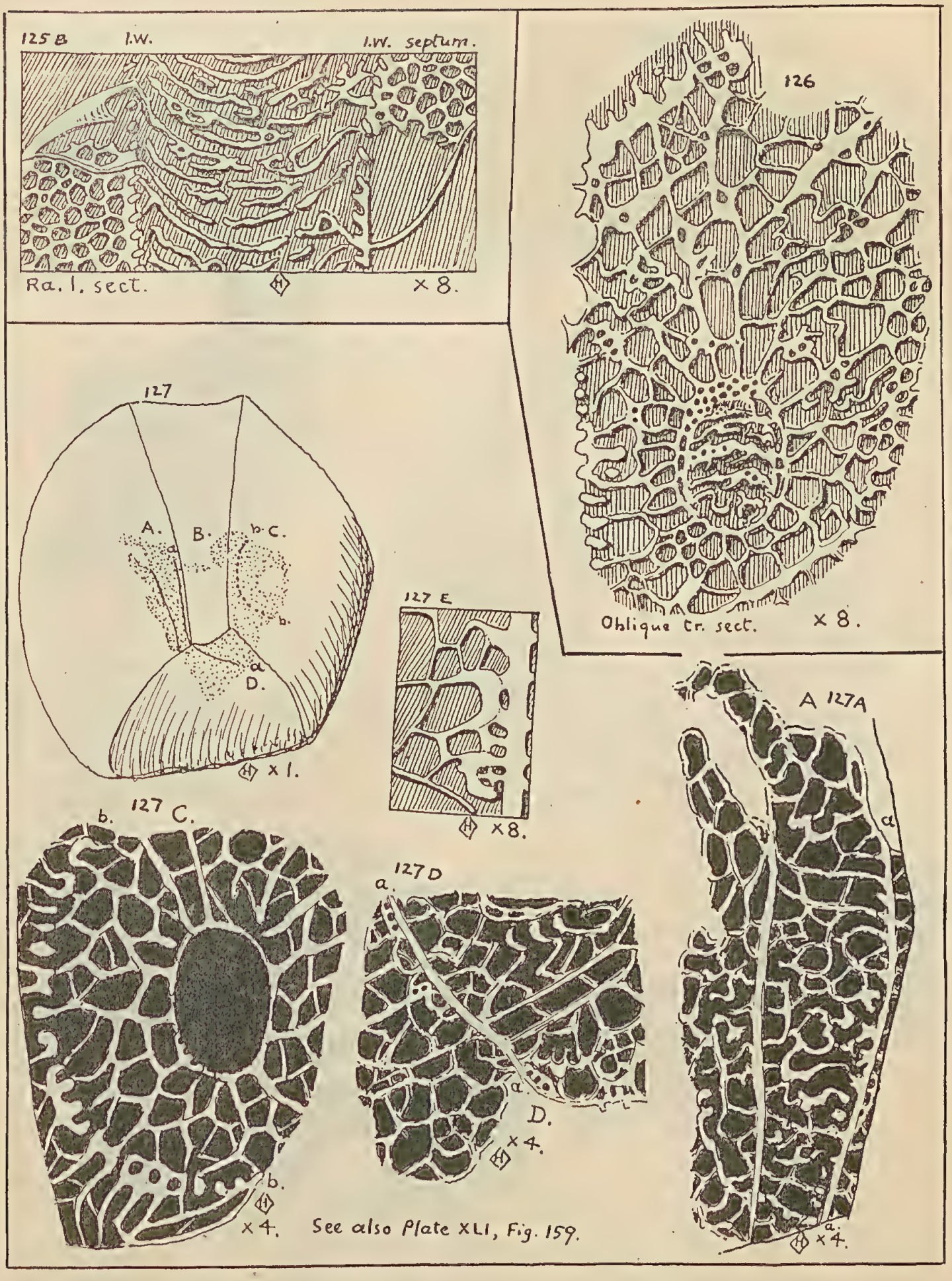
111. Flindersicyathus tabulatus.
112. F. macdonnelli.
113. c/f Archaeofungia ajax.
114. Sigmofungia fragilis.
115. Sigmofungia tabularis.
116. Copleicyathus confertus.



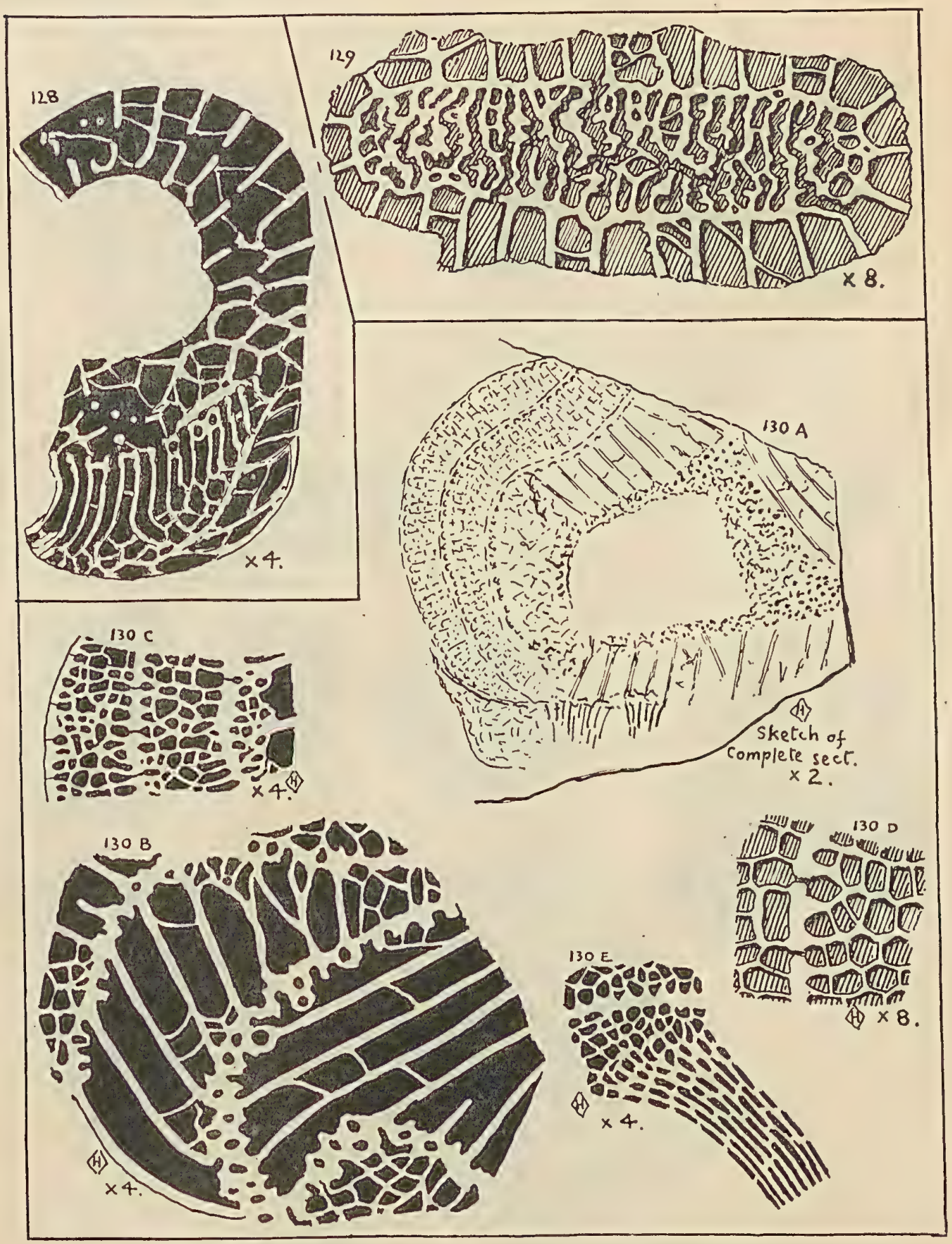
116. Copleicyathus confertus.
117. Spiralicyathus pigmentum.
118. Spiralicyathus tenuis.
119. Syringocnema spriggi.
120. Archaeopharetra typica.



120. Archaeopharetra typica.
121. A. tenuis.
122. A. syrinx.
123. Archaeopharetra or Metacyathus.
124. Metacyathus sp. or v. ramulosus.
125. Ardrossacyathus endotheca.

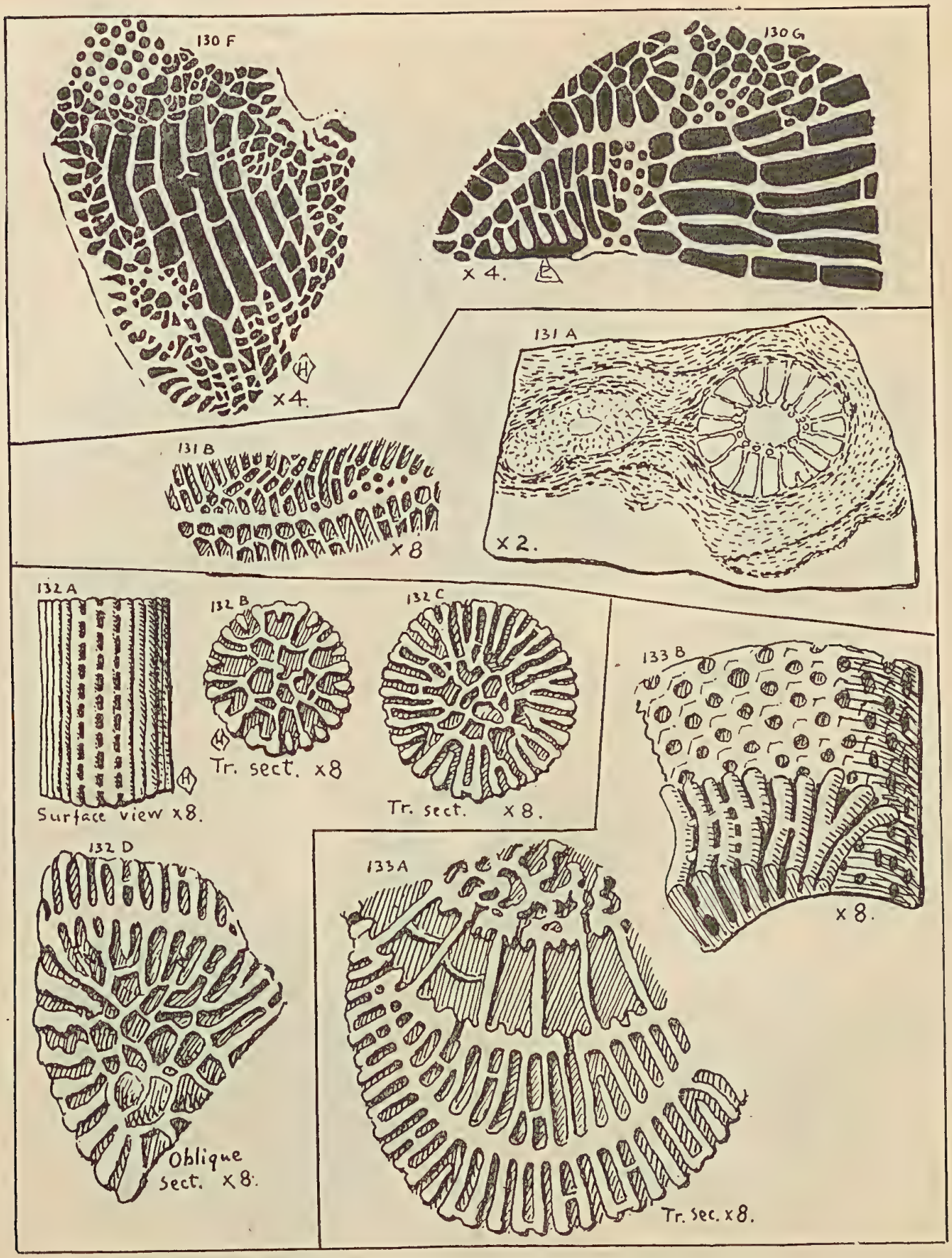


125. Ardrossacyathus endotheca.
126. c/f Ardrossacyathus or Metaldetimorpha.
127. Metaldetimorpha yorkei.

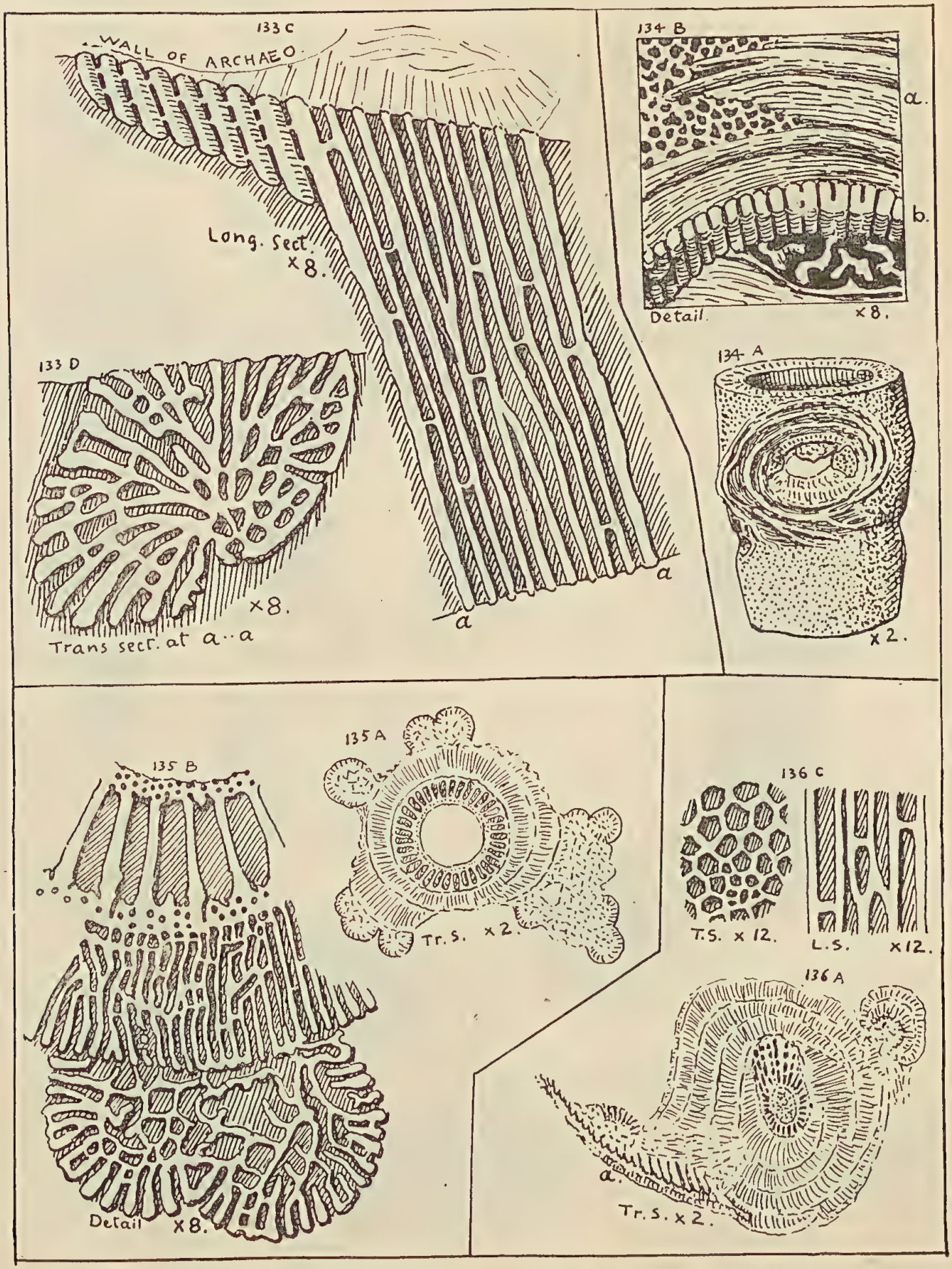


128. Metaldetimorpha yorkei.

129. Metaldetimorpha or Ardrossacyathus.
130. Metaldetimorpha flindersi.

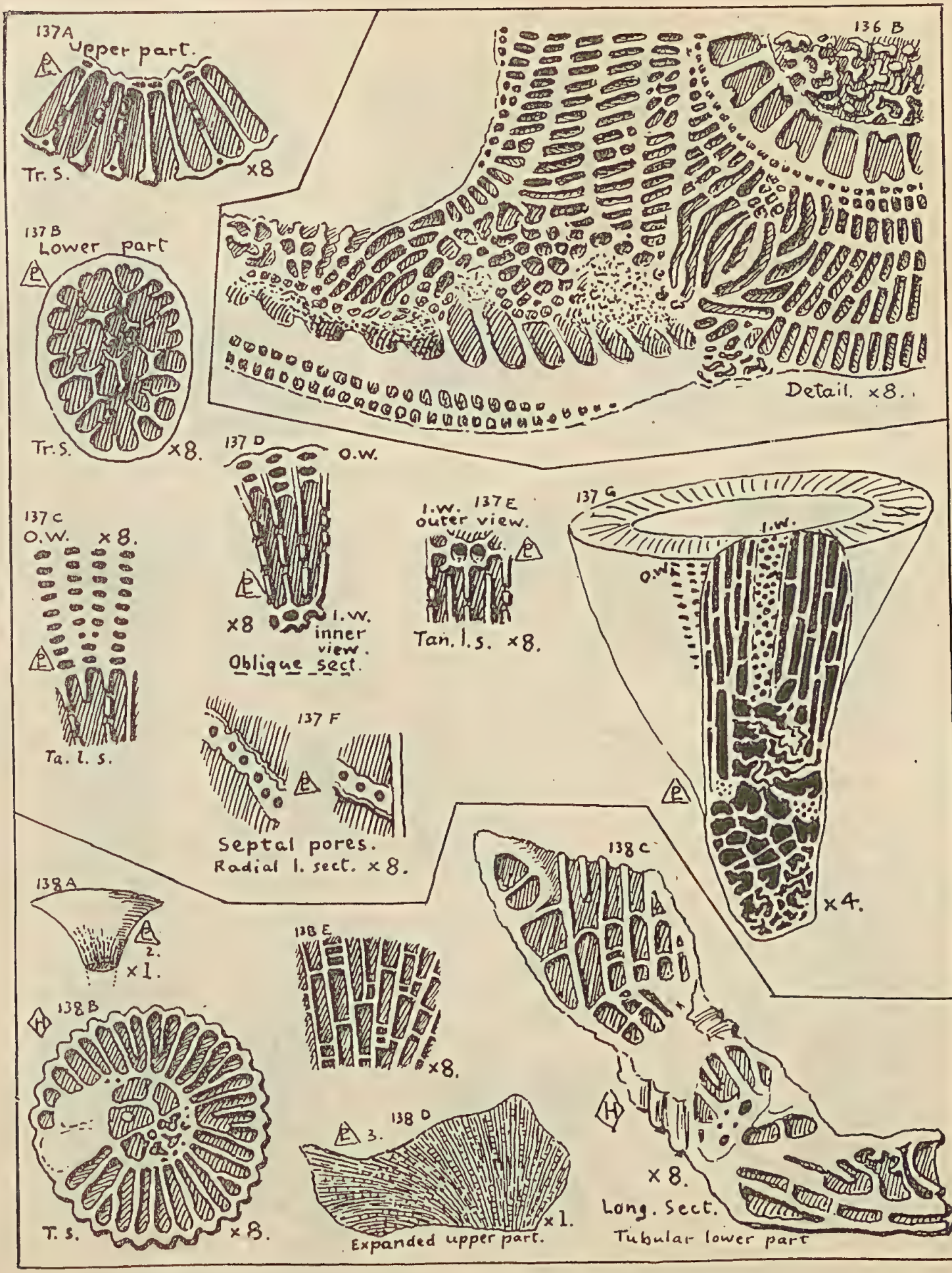


130. Metaldetimorpha flindersi.
131. Metaldetimorpha or Exocyathus with Protopharetra and Beltanacyathus.
132, 133. Exocyathus australis (Ajax variety).

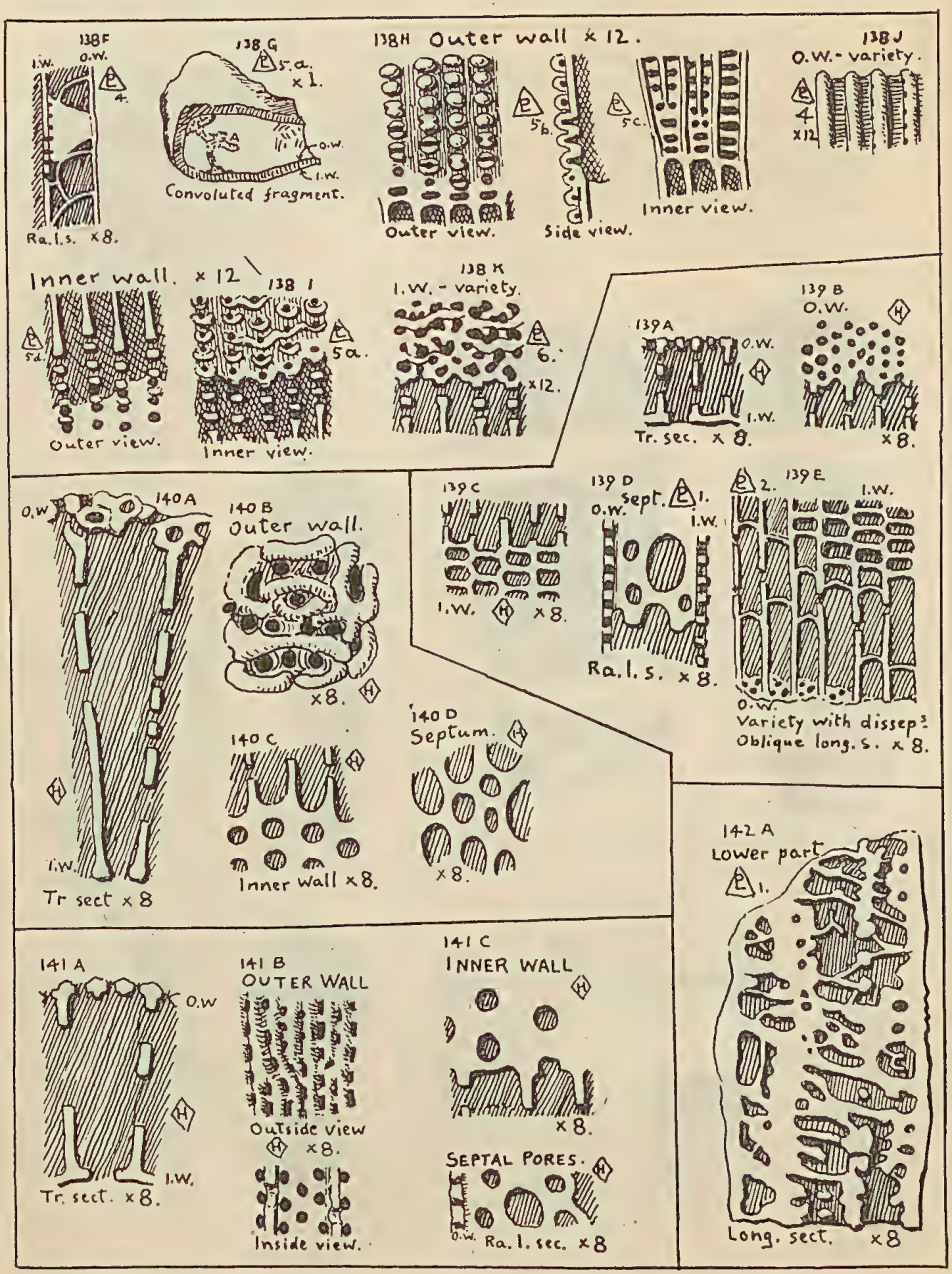


133, 134. Exocyathus australis (Ajax variety).

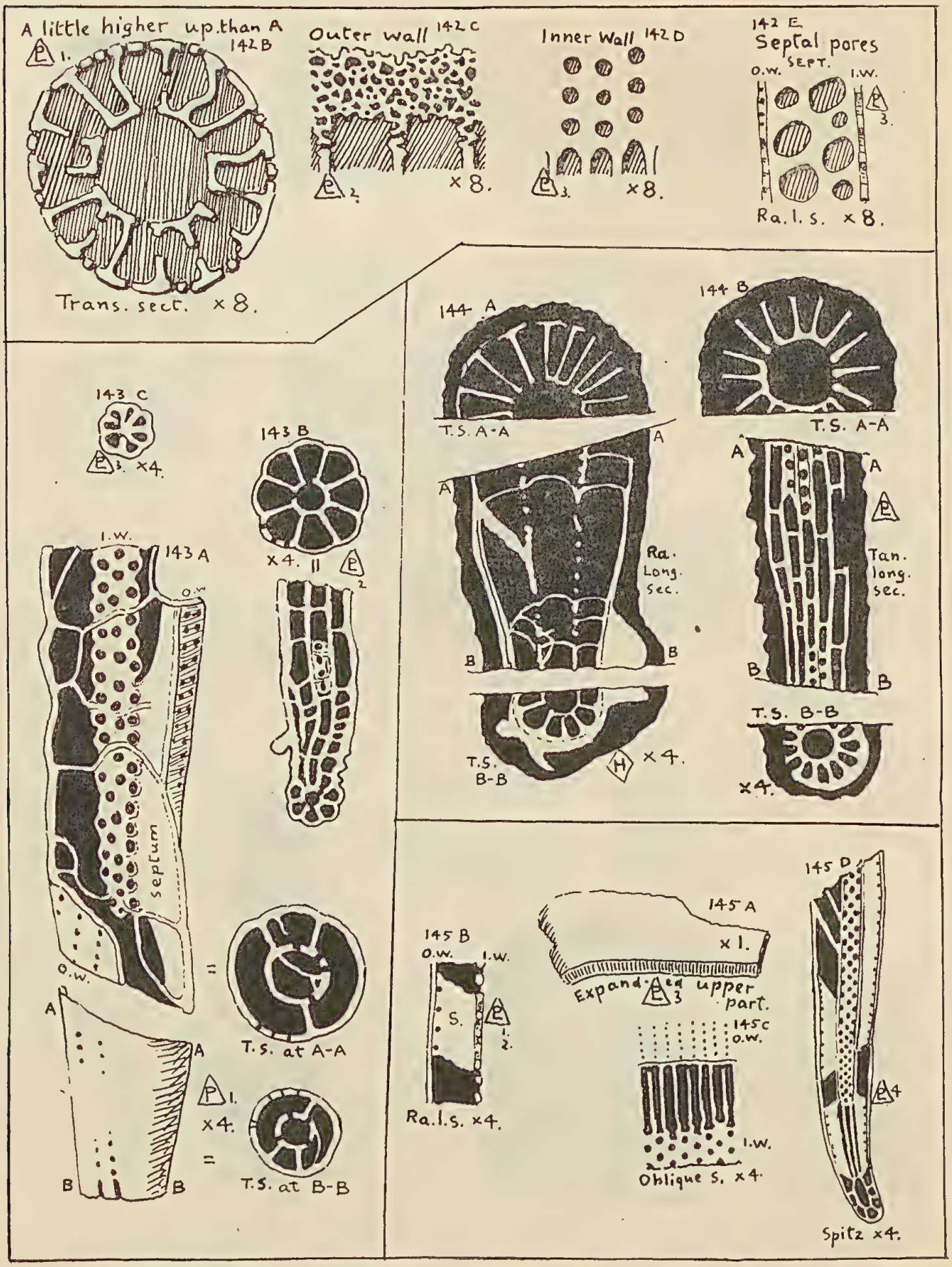
135. Exocyathus australis (Ardrossan variety).
136. Exocyathus australis (Carrickalinga variety).



136. Exocyathus australis (Carrickalinga).
137. Paranacyathus parvus.
138. Paranacyathus margarita.

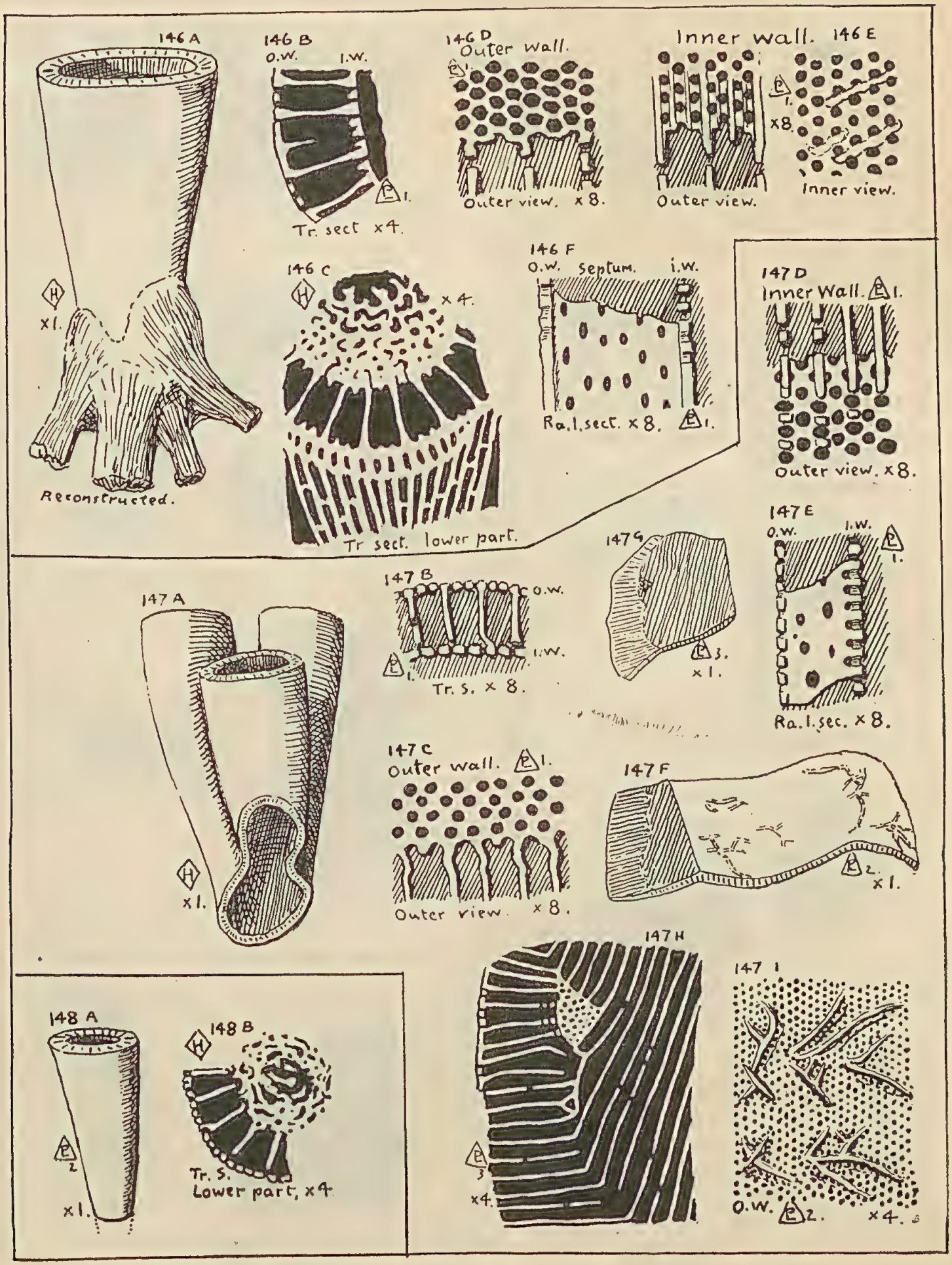


138. Paranacyathus margarita.
139. P. regularis.
140. P. grandis.
141. P. cortex.
142. P. (archaeocyathus) magnipora.



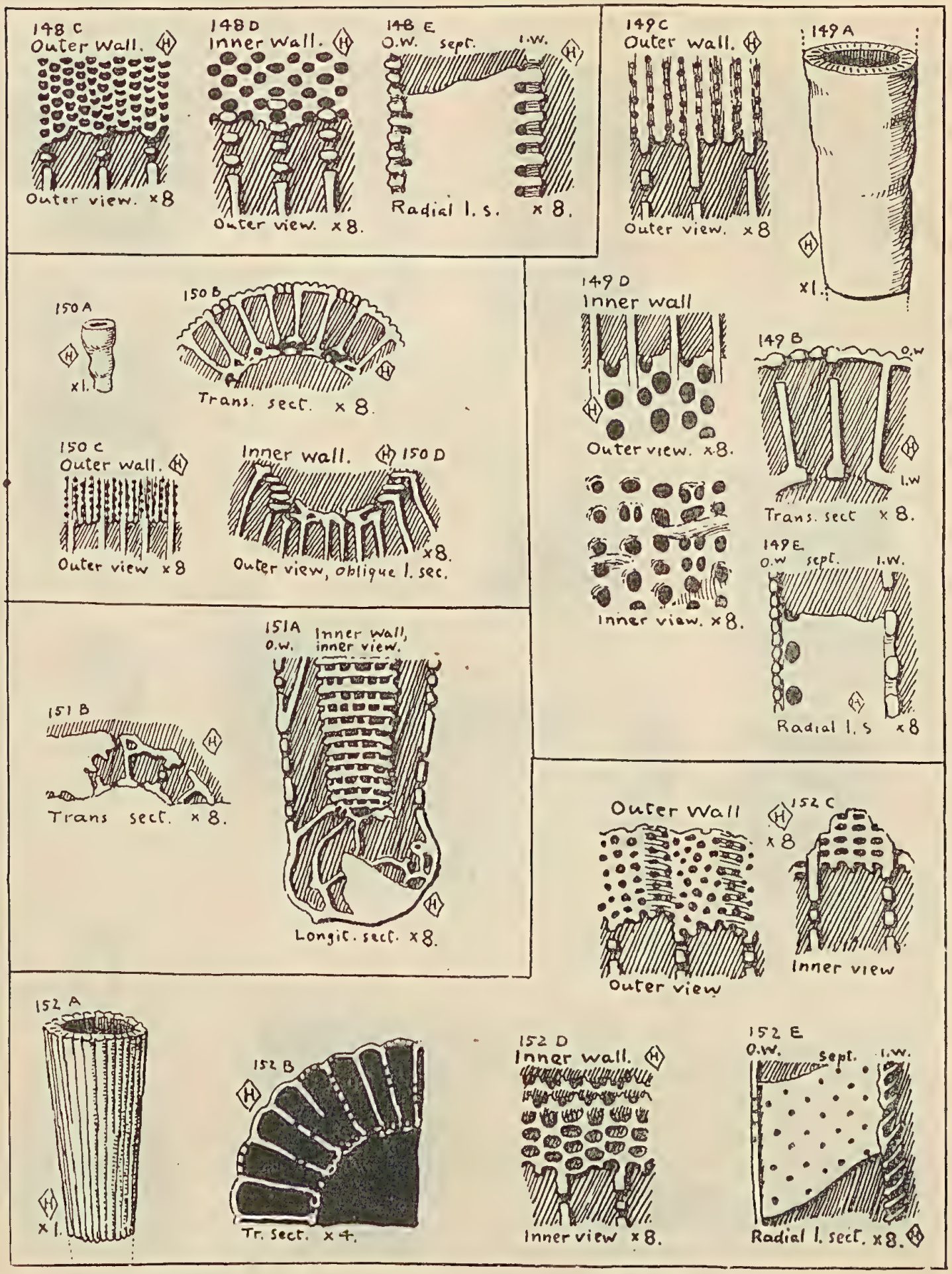
142. P. (archaeocyathus) magnipora.
143. Archaeocyathus floreus.

144. Ardrossan specimens.
145. Archaeocyathus subacutus.

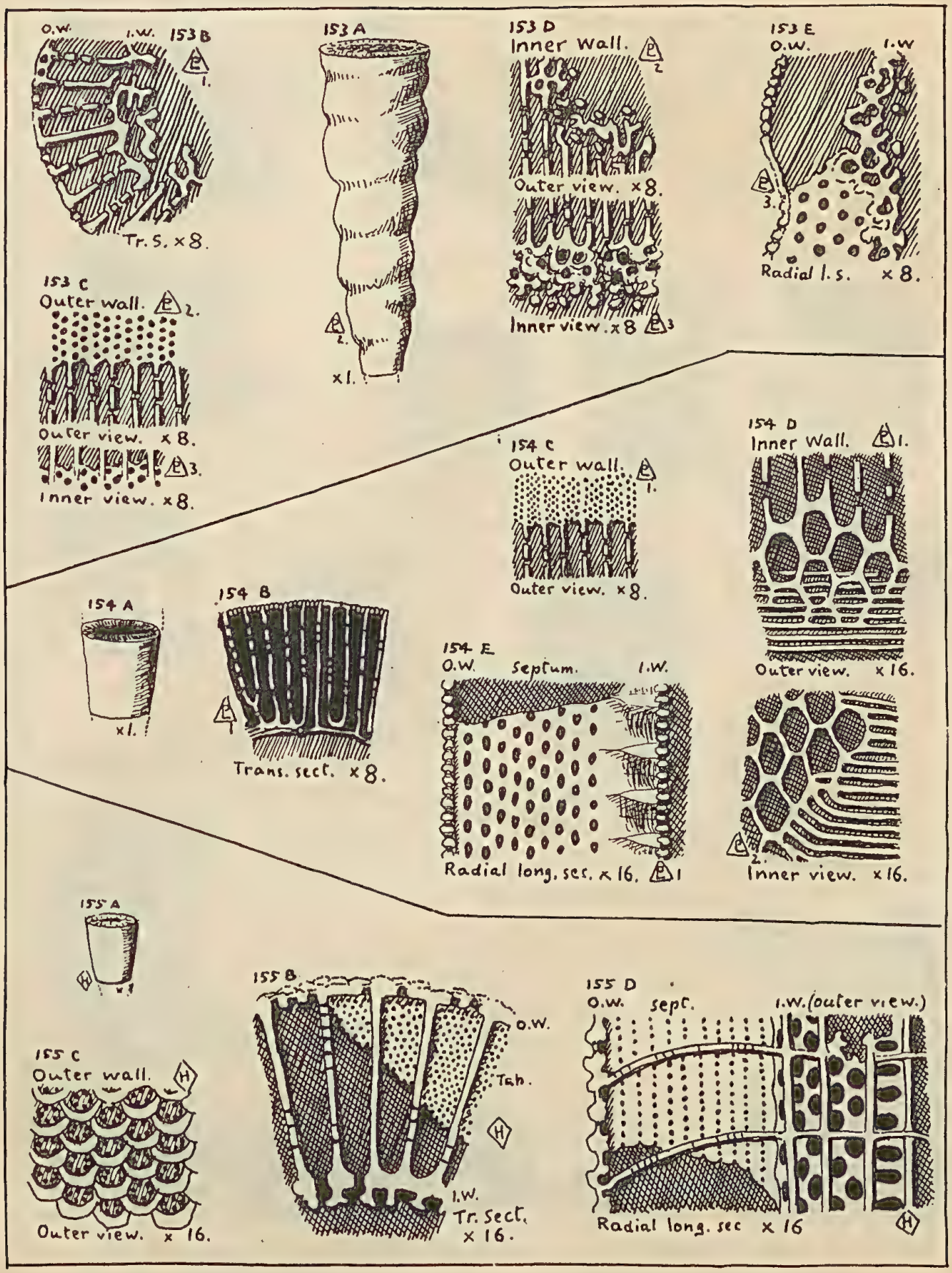


146. Archaeocyathus aequisemis.
147. Archaeocyathus aequitriens.

148. Archaeocyathus endothecalis.

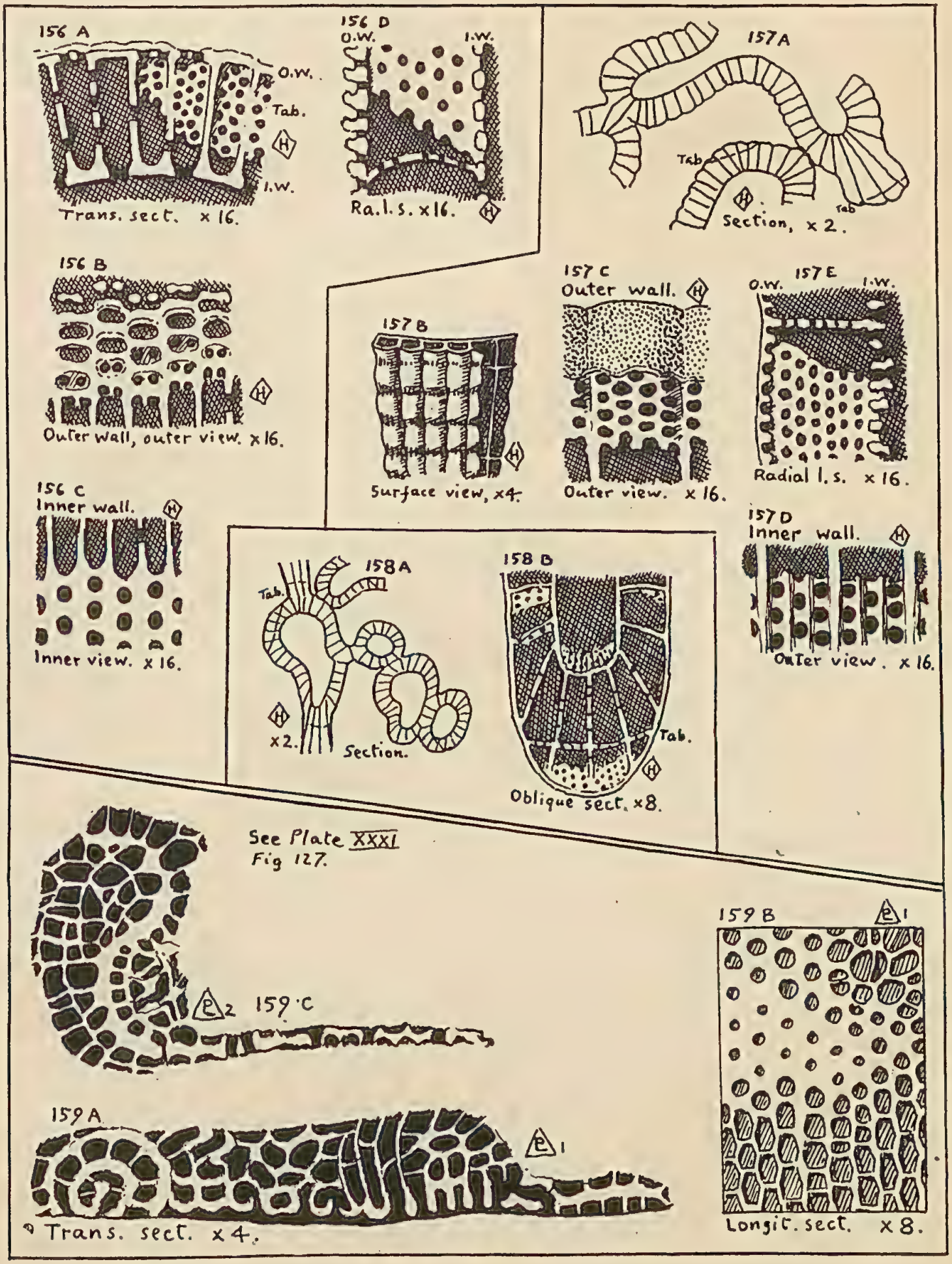


148. Archaeocyathus endothecalis.
149. A. brunhilda.
150. A. carmen.
151. A. josephina.
152. Cadniacyathus asperatus.



153. Zonacyathus retevallum.
154. Ethmocyathus lineatus.

155. Coscinocyathus minimiporus.



156. Coscinocyathus sylvia.
157. Polycoscinus contortum.
158. Polycoscinus complexum.
159. Metaldetimorpha yorkei.

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